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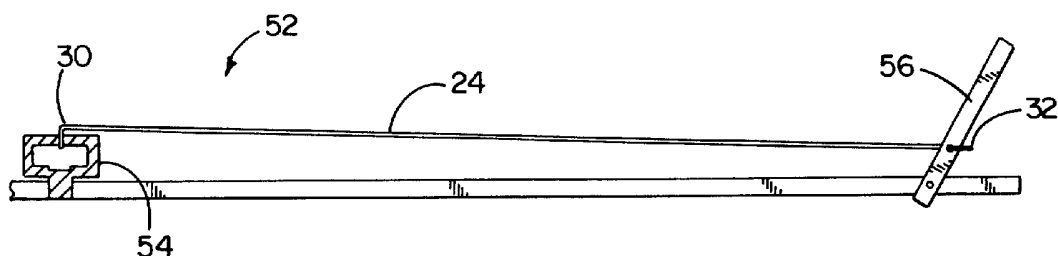
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(54) Title: APPARATUS AND METHOD FOR MANUFACTURING TEMPERATURE SENSITIVE CABLE



(57) **Abstract:** An apparatus and method for manufacturing temperature sensitive thermocouple cable are disclosed. The method includes the steps of inserting a tamping tube within an outer metal sheath, wherein the tamping tube includes apertures positioned therein for appropriate positioning of thermocouple wires. The thermocouple wires are introduced into the apertures with the outer sheath then being filled with a powdered insulating material having a negative temperature coefficient while the tamping tube is removed. In so doing, the insulating material is compacted around the thermocouple wire and the thermocouple wires are appropriately positioned in parallel disposition within the outer sheath. The ends of the outer sheath are enclosed with rubber stoppers which also secure the ends of the thermocouple wires. The resulting assembly is then drawn to a reduced diameter and annealed as appropriate to produce a temperature sensitive cable tailored to a specific application.

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APPARATUS AND METHOD FOR MANUFACTURING TEMPERATURE SENSITIVE CABLE

FIELD OF THE INVENTION

The invention generally relates to temperature sensitive devices and, more particularly, relates to temperature sensitive cables and methods and apparatus for manufacturing such cables.

BACKGROUND OF THE INVENTION

Temperature sensitive cables are well-known. Such cables may be characterized by the use of semi-conductive materials having inverse temperature-resistance characteristics in conjunction with dissimilar thermoelectric conductors. Such cables are particularly suitable where it is desired to monitor the greatest temperature existing along the length of the cable. An example of such a system is disclosed in U.S. Patent No. 3,408,607.

Another type of temperature sensitive cable is referred to as a thermistor cable which is characterized by a core of semi-conductive materials surrounded by a mass of temperature resistant electrically insulating material covered with a protective metallic sheath.

In a still further type of temperature sensitive cable, known as a thermocouple cable, the cable is characterized by a metallic tubular sheath containing two dissimilar metal thermocouple wires packed in a semi-

conductive ceramic powder. Such a cable can detect temperatures across a vast range of approximately -20°F to 1650°F. Such cable can not only detect an increase in temperature, but also the exact location of the increase at any point along the length of the cable. Such cables have proven to be extremely successful and versatile in a variety of applications, and are disclosed in, for example, my previous U.S. Patent Nos. 4,324,138; 4,491,822; 4,540,972; and 4,614,024.

The methods for manufacturing temperature sensitive cables are also varied. For example, U.S. Patent No. 3,737,997 describes a method wherein a metallic tube is positioned vertically with one or more conductors within the tube. The tube is then filled with insulating powder while the tube is vibrated so as to compact the powder within the tube and around the conductors.

Other methods, such as that disclosed in U.S. Patent No. 4,614,024, involve the steps of curling and welding a strip of metal into a tube around one or more conductors. The method further includes the step of concurrently filling the tube with insulating powder while the strip is being advanced, curled and welded into a tube.

While such cables and methods of manufacturing have proven to be extremely effective, it would be advantageous to produce even more accurate temperature sensitive cables in an even more efficient and effective manner.

SUMMARY OF THE INVENTION

In accordance with one aspect of the invention, a method of manufacturing temperature-sensitive cable is provided, which comprises the

steps of positioning a tamping tube within an outer tube, inserting thermocouple wires through apertures in the tamping tube, closing a first end of the outer tube, filling the outer tube with an insulating material while retracting the tamping tube out of the outer tube, closing a second end of the tube, drawing the tube into a smaller diameter cable, and annealing the cable.

In accordance with another aspect of the invention, a method of manufacturing temperature sensitive cable is provided comprising the steps of inserting a tamping tube into an inconel tube, sliding first and second thermocouple wires into the tamping tube, securing a stopper to first ends of the thermocouple wires, inserting the stopper into a first end of the inconel tube, standing the inconel tube with inserted tamping tube and thermocouple wires upright with a second end of the inconel tube being higher than the first end, filling the inconel tube with an insulating powder, pulling the tamping tube out of the inconel tube during the filling step, securing a second stopper to second ends of the thermocouple wires, inserting the stopper into a second end of the inconel tube, drawing the inconel tube into a smaller diameter, and annealing the inconel tube.

In accordance with another aspect of the invention, an apparatus for manufacturing a temperature sensitive cable is provided which comprises a tamping tube, a fill stand, and a vibrator. The tamping tube is adapted to be inserted into an outer sheath and includes at least one aperture for receipt of thermocouple wire. The fill stand has a plurality of clamps affixed to the fill stand and is adapted to hold the outer sheath in an upright position. The vibrator is operatively associated with the fill stand and is adapted to vibrate

the fill stand and outer tube as the outer tube is filled with an insulating material.

These and other aspects and features of the invention will become apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal cross-sectional view of a temperature sensitive cable constructed in accordance with the teachings of the invention;

FIG. 2 is a flow chart depicting a sequence of steps used in conjunction with the method according to the teachings of the invention;

FIG. 3 is a cut-away sectional view of a tube being cleaned in accordance with the teachings of the invention;

FIG. 4 is a side view of a thermocouple wire straightening device according to the teachings of the invention;

FIG. 5 is a horizontal cross-sectional view of an outer tube with tamping tube inserted therein in accordance with the teachings of the invention;

FIG. 6 is a perspective view of a fill stand with clamps and vibrating assembly constructed in accordance with the teachings of the invention;

FIG. 7 is a perspective view of the fill stand of FIG. 6, but with the tamping tube being removed and received within a support tube thereabove;

FIG. 8 is a strip chart illustrating the homogeneity of a cable constructed in accordance with the teachings of the invention;

FIG. 9 is a strip chart illustrating the homogeneity of a cable constructed without tamping; and

FIG. 10 is a temperature resistance curve of a cable constructed in accordance with the teachings of the invention.

While the invention is susceptible to various modifications and alternative constructions, certain illustrative embodiments thereof have been shown in the drawings and will be described below in detail, it should be understood, however, that there is no intention to limit the invention to the specific forms disclosed, but on the contrary, the intention is to cover all modifications, alternative constructions and equivalents falling within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and with specific reference to FIG. 1, a thermocouple cable constructed in accordance with the teachings of the invention is generally referred to by reference numeral 20. As shown therein, the cable 20 includes an outer sheath 22 within which are disposed first and second thermocouple wires 24, 26 surrounded by a volume of insulating material 28. Each of the thermocouple wires 24, 26 includes a distal end 30 and a proximal end 32 received in stoppers 34, 36, respectively. The cable 20, once assembled in accordance with the teachings of the invention, as will be described in further detail herein, form an assembly 37 which can then be drawn by conventional wire drawing machines and dies to reduce the

diameter thereof. The reduced diameter cable 20 can then also be annealed prior to use.

The outer sheath 22 is preferably manufactured from inconel, a corrosion resisting alloy of 80% nickel, 14% chrome and 6% iron. The outer sheath 22 may be cut to any desirable length, but for the purpose of providing one example of known dimension, may be eleven feet long with an outer diameter of one half inch. The thermocouple wires 24, 26 are preferably nickel/chromium-nickel/aluminum type "K" thermocouple wires having a diameter of .076 inches and a length of, if used with the aforementioned eleven feet long outer sheath 22, eleven feet, two inches. The insulating material is preferably manganese powder which has been sifted through a sieve having screen openings of .0117 square inches. Optionally, for high temperature sensors, the manganese powder may be baked at 1850°F for approximately four hours prior to sifting. The stoppers 34, 36 are preferably manufactured from rubber and include first and second holes each having a diameter of .09375 inches and cable being spaced apart within the stopper .093 inches. It is to be understood that the above materials and dimensions are provided for the purpose of disclosing the currently known best mode for practicing the teachings of the invention, and should not be construed as limiting in any manner.

Referring now to FIG. 2, the flow chart thereof depicts a sequence of steps which may be taken in accordance with the teachings of the invention to produce thermocouple cable 20. As shown therein, a first step 38 thereof is the preparation of an inner circumferential surface 40 of the outer sheath 22.

As indicated above, the outer sheath 22 is preferably manufactured from inconel and cut in predetermined lengths. Prior to further processing, the inner circumferential surface 40 of the outer sheath 22 is cleaned with 90% of isopropyl alcohol. The isopropyl alcohol can be sprayed within the outer sheath 22 and an abrasive tool 42 can then be inserted into the outer sheath 22 to engage the interior circumferential surface 40. For example, as shown in FIG. 3, the abrasive brush 42 can be attached to a power drill 44 for rotation thereof. The rotating abrasive tool 42 is then inserted into the outer sheath 22, which in conjunction with the isopropyl alcohol sufficiently cleans the interior circumferential surface 40. The outer sheath 22 may be secured to a bench or similar surface for performance of step 38. A cleaning cloth may then be placed over a first end 46 of the outer sheath 22 and pushed through the outer sheath 22 using an extended rod or the like to remove the isopropyl alcohol and any particles removed during the abrasive action. The outer sheath 22 is then preferably stood upright to allow drying.

Referring again to FIG. 2, after the outer sheath 22 is prepared, the first and second thermocouple wires 24, 26 need to be prepared as indicated by a step 50. As shown in FIG. 4, the wires 24, 26 may be straightened using a wire straightening assembly 52. The wire straightening assembly 52 includes a clamp or a vice 54 as well as a pivotable lever arm 56. The thermocouple wires 24 and 26 are attached at distal ends 30 to the vice 54 and at proximal ends 32 to the lever 56. The lever 56 is then moved manually, or by the assistance of automated power, a sufficient distance to

straighten the wires 24 and 26. Each of the wires 24 and 26 is also preferably cleaned using 90% isopropyl alcohol and a clean cloth.

Again with reference to FIG. 2, the process is depicted to include a step 58 of inserting a tamping tube 60 into the outer sheath 22. As shown best in FIG. 5, the tamping tube 60 includes a substantially solid inner core 62 at a working end 63. The inner core 62 extends a short distance into the outer sheath 22, e.g. one inch, and includes first and second linear apertures or channels 64 and 66 extending therethrough. About an exterior circumferential surface 68 of the tube 60 are a plurality of spacers 70. The spacers 70 may be attached to the exterior surface 68 as by brazing, welding, or the like. The spacers 70 are dimensioned so as to produce an effective outer diameter 72 slightly less than an inner diameter 74 of the outer sheath 22. This is of importance in that it places the linear apertures 64 and 66 into precise location within the outer sheath 22 for introduction of the thermocouple wires 24 and 26 as will now be described.

Once the tamping tube 60 is positioned within the outer sheath 22, as indicated in FIG. 5, the thermocouple wires 24 and 26 are slid into the linear apertures 64 and 66 as indicated by a step 76. The wires 24, 26 are preferably cut into lengths slightly longer than the outer sheath 22, such that their distal and proximal ends 30 and 32 extend past the first end 46 and second end 78, respectively, of the outer sheath 22. However, it is to be understood that should the outer sheath 22 be cut to a length other than the aforementioned eleven feet, the lengths of wires 24 and 26 would not be the

aforementioned eleven feet, two inches in length, but would be proportionally altered.

In a step 80, the proximal ends 32 of the thermocouple wires 24 and 26 are inserted into the holes 82 and 84, respectively, provided within the first stopper 34. The first stopper 36 is then inserted into the first end 46 of the outer sheath 22. The stopper 36 is dimensioned so as to frictionally engage the inner surface 40 of the outer sheath 22. It is preferable to use a hand tool such as a screw driver to completely insert the stopper 36 into the outer sheath 22. The proximal ends 32 of the thermocouple wires 24 and 26 are bent, as indicated in a step 82, at right angles or the like to inhibit their ability to retract back into the outer sheath 22.

Referring again to FIG. 2, the outer sheath 22, tamping tube 60, and thermocouple wires 24 and 26 form the assembly 37 which is then placed within a fill stand 84 as indicated by a step 86. As shown in FIG. 6, the fill stand 84 preferably includes a substantially flat surface 88 extending vertically within an open, sufficiently high, space. The flat surface 88 also preferably includes at least one groove 90 for receipt of the outer sheath 22 therein. A plurality of clamping assemblies 92 are provided proximate the groove 90 to securely hold the outer sheath 22 into the groove 90 of the fill stand 84.

As indicated in FIG. 2, the next step in the process is to fill the outer sheath 22 with the insulating material 28. To facilitate this process, a funnel or hopper may be provided on the fill stand 84 so as to be above the second end 78 of the outer sheath 22 when secured into the fill stand 84. During the filling step, indicated by a numeral 96 in FIG. 2, the outer sheath 22 is

preferably vibrated while the tamping tube 60 is retracted out of the outer sheath 22, as shown in FIG. 7. A support tube 97 is provided above the fill stand 84 to receive and laterally support the tamping tube 60 as it is retracted from the outer sheath 22.

The insulating material 28 can be introduced through the hopper manually or automatically. To facilitate the vibrating process, a plurality of power vibrators 98 are fixed to the fill stand 84 at spaced locations. The vibrating motion created by the vibrators 98 causes the powdered insulating material 28 to settle and compact within the outer sheath 22 around the thermocouple wires 24 and 26, with the tamping tube 60 also assisting the process. More specifically, the tamping tube 60 is preferably retracted from the outer sheath 22 in an oscillating motion with its proximal end engaging the insulating material 28 in a compacting motion before being retracted a short distance and then being reintroduced into the outer sheath 22 to again compact the insulating material 28. The vibration and tamping step is indicated as a step 99 in FIG. 2.

Heat sensitive cable insulation, which is affected by changes in temperature, is known as having an inverse temperature characteristic since the resistance of the insulation is reduced as the temperature to which it is subjected is increased and vice-versa. Due to the relatively low input impedance of standard thermocouple type measuring instruments, it is important that the value of the insulation resistance of the cable falls preferably within a range of one thousand (1000) to ten thousand (10,000) ohms at the ambient temperature at which it will be used.

Another factor, which contributes to the accuracy of the temperature measurement by heat sensitive cable, is the consistency or homogeneity of the insulation's pack density throughout the entire length of the cable. The consistent tamping of the insulation around the thermocouple wires while filling the outside tube provides a demonstrable and important improvement in the homogeneity, and thus the accuracy of the temperature measurement at any and every point along the length of the cable.

Measurement and certification of homogeneity may be obtained by, for example, advancing the cable through a one (1) inch diameter, three (3) foot long heated tube, and measuring and comparing the response to temperatures generated by each three (3) feet of cable. The improvement afforded by the vibrating and tamping process taught by the present invention, is depicted in the strip chart in FIG. 8, compared to the strip chart of FIG. 9, which depicts the homogeneity of a cable filled without tamping.

The above feature is an important difference in a cable constructed according to the teachings of the invention in that it is able to accurately measure not only ambient temperatures, but an abnormal increase in temperature which may occur anywhere along its entire length. Comparing the two strip chart recordings of FIGS. 8 and 9, it can be easily seen that the continuous tamping action while filling, which can be done either manually as indicated above or with appropriate commercially available linear motion devices, produces a cable with an insulation pack density (homogeneity) which is substantially improved. It therefore provides a heat sensing cable which not only accurately measures variations in ambient temperature, but

also accurately measures the actual maximum temperature above ambient developing at any point (local temperature increase) along the entire length of the cable.

To be compatible with the majority of current temperature measuring, transmitting, recording and display instruments, it is advantageous to provide a heat sensitive cable that has an insulation resistance (impedance) value between approximately one (1) to ten (10) K ohm over specific operating ambient temperature ranges. To provide a single cable construction capable of providing maximum accuracy of localized increases in temperature when operating in different ambient temperature ranges, it is necessary to first produce a product for use over the entire range and then control the heat treating of the cable to produce the most effective resistance for a given operating temperature range. This may be accomplished by selectively heat-treating to produce a cable with similar resistance values at operating ambient temperatures of 100°F, 200°F, 300°F, 400°F and so forth. For general understanding, these operating ambient temperature ranges are given classifications of roman numerals I, II, III, IV, and so forth.

Once the outer sheath 22 is completely filled with insulating material 28, which in the preferred embodiment corresponds to filling the outer sheath 22 to approximately one half inch from the second end 78, the second stopper 34 is secured to the distal ends 32 of the thermocouple wires 24 and 26 and then to the second end 78 of the outer sheath 22 as indicated by a step 100.

The assembly 37 is then subjected to a series of drawing and annealing steps, 101 and 102, respectively to both reduce the diameter of the cable 20, and temper its metal. While the number of iterations of the drawing and annealing steps 101 and 102 can vary, the inventor has found that, in general, the cable 20 should be drawn a minimum of two times for every time the cable is annealed until the desired diameter is achieved. The inventor has also found that a outer sheath 22 having an initial length of ten feet, three inches, will draw to about one hundred and forty feet at an outer diameter of .12 inches.

The following are examples of different drawing and annealing steps 101 and 102, respectively, which can be performed to produce cables 20 of different sensing capability. For a class IV sensor as defined above, the cable 20 should be drawn approximately twenty times and annealed approximately ten times. The annealing should occur within an evacuated oven heated to 1250°F for a minimum of fifteen minutes, followed by heating at 1600°F for a minimum of thirty minutes. For class V sensors, the class IV sensor should be redrawn at 0.12 inches and annealed at 1650°F. For class VI sensor, the class V sensor should be redrawn at 0.12 inches and annealed again at 1650°F to result in a total of 22 draws and 12 anneals.

In operation, the cable 20 functions as follows. The cable 20 contains a continuous pair of dissimilar thermocouple conductors 24, 26 insulated from each other by densely packed, specially processed insulation 28. The insulation 28 has a high negative temperature coefficient (NTC), i.e., as the temperature applied to the insulation increases, the electrical resistance of

the insulation decreases rapidly. When, at any point along the cable length, a temperature exceeding the temperature of the remainder of the cable occurs, the electrical resistance of the NTC insulation 28 between the thermocouple conductors 24, 26 is reduced at that point, and a temporary thermocouple junction is formed at, for example, a location α (not shown). If a second and hotter temperature occurs at any other point on the cable, for example at a location β (not shown), the resistance between the conductors at β will be reduced below the resistance at α and a new temporary thermocouple junction will be formed. This temporary thermocouple junction performs the same as a conventional single point thermocouple junction. The actual insulation resistance values at α or β are of special significance and must be within the capabilities of the monitoring instrument. Frequently, the maximum thermocouple input impedance value that the instrument can accept without error is 15 to 25 K ohms.

As can be seen by the temperature resistance curve of FIG. 10, for a heat sensitive cable required to operate at an ambient temperature of 700°F and provide an alarm at 800°F, the resistance of the cable at 700°F is preferably between one thousand and ten thousand ohms. It can be seen that the room temperature (72°F) resistance must be considerably higher (in the order of magnitude of megohms). This then compares to a requirement of three (3) megohms at 72°F, for a cable which is to have a similar one thousand (1000) to ten thousand (10,000) ohm resistance when operating at an ambient temperature of 400°F.

From the foregoing, one of ordinary skill in the art will appreciate that the invention provides a method for manufacturing temperature sensitive cable and an apparatus for accomplishing same.

WHAT IS CLAIMED IS:

1. A method of manufacturing temperature-sensitive cable, comprising the steps of:
 - positioning a tamping tube within an outer tube;
 - inserting thermocouple wires through apertures in the tamping tube;
 - closing a first end of the outer tube;
 - filling the outer tube with an insulating material while retracting the tamping tube from the outer tube;
 - closing a second end of the outer tube;
 - drawing the tube into a smaller diameter cable; and
 - annealing the cable.
2. The method of claim 1, wherein the thermocouple wires are a combination of nickel/chromium and nickel/aluminum.
3. The method of claim 1, wherein the tube is made of inconel.
4. The method of claim 1, further including the step of cleaning an inner circumferential surface of the tube prior to the inserting step.

5. The method of claim 4, wherein the cleaning step includes the steps of spraying isopropyl alcohol into the tube, engaging an abrasive tool against the inner circumferential surface, and drying the inner circumferential surface.

6. The method of claim 1, wherein the tamping tube includes one linear aperture for receipt of the thermocouple wires.

7. The method of claim 6, wherein the tamping tube includes first and second apertures adapted to receive thermocouple wire in a spaced, parallel relationship.

8. The method of claim 6, further including the step of tamping the tamping tube against the insulating material during the filling step.

9. The method of claim 8, further including the step of vibrating the outer tube during the tamping step.

10. The method of claim 9, further including the step of inserting the tamping tube into a support tube during the tamping step.

11. The method of claim 1, wherein the closing steps are performed using rubber stoppers, each rubber stop receiving an end of the thermocouple wires.

12. The method of claim 1, wherein the filling step is performed using manganese powder.

13. The method of claim 12, further including the step of baking the manganese powder at approximately 1850°F for approximately four hours prior to the filling step.

14. The method of claim 12, further including the step of sifting the manganese powder through a 0.0117 sieve prior to the filling step.

15. The method of claim 1, further including the step of straightening the thermocouple wire prior to the inserting step.

16. The method of claim 1, further including the step of standing the outer tube upright before the filling step.

17. The method of claim 16, wherein the standing step is performed by clamping the outer tube in a fill stand.

18. The method of claim 1, wherein the drawing step is preferably performed twice for every time the annealing step is performed.

19. The method of claim 1, wherein the drawing step is performed a sufficient number of times to reduce the outer tube from a diameter of approximately 0.5 inches to approximately 0.12 inches.

20. The method of claim 1, wherein the annealing step is performed at a temperature within the range of about 1250°F to about 1650°F.

21. A method of manufacturing temperature-sensitive cable, comprising the steps of:
- inserting a tamping tube into an inconel tube;
 - sliding first and second thermocouple wires into the tamping tube;
 - securing a stopper to first ends of the thermocouple wires;
 - inserting the stopper into a first end of the inconel tube;
 - standing the inconel tube with the inserted tamping tube and thermocouple wires upright and with a second end of the inconel tube being higher than the first end;
 - filling the inconel tube with an insulating powder;
 - pulling the tamping tube out of the inconel tube during the filling step;
 - securing a second stopper to second ends of the thermocouple wires;
 - inserting the stopper into a second end of the inconel tube;
 - drawing the inconel tube into a smaller diameter; and
 - annealing the inconel tube.

22. An apparatus for manufacturing a temperature sensitive cable, comprising:

a tamping tube adapted to be inserted into an outer sheath, the tamping tube having at least one aperture for receipt of thermocouple wire;

a fill stand having a plurality of clamps affixed thereto, the fill stand adapted to hold the outer sheath in an upright position; and

a vibrator operatively associated with the fill stand and adapted to vibrate the fill stand and outer tube as the outer tube is filled with an insulating material.

23. The apparatus of claim 22, further including a support tube disposed above the fill stand and adapted to receive and support the tamping tube as it is pulled from the outer sheath.

24. The apparatus of claim 22, further including a hopper proximate a top of the fill stand, the hopper having an inlet for receipt of the insulating material and an outlet for communicating the insulating material to the outer sheath.

25. The apparatus of claim 22, further including a wire straightening device adapted to straighten the thermocouple wire.

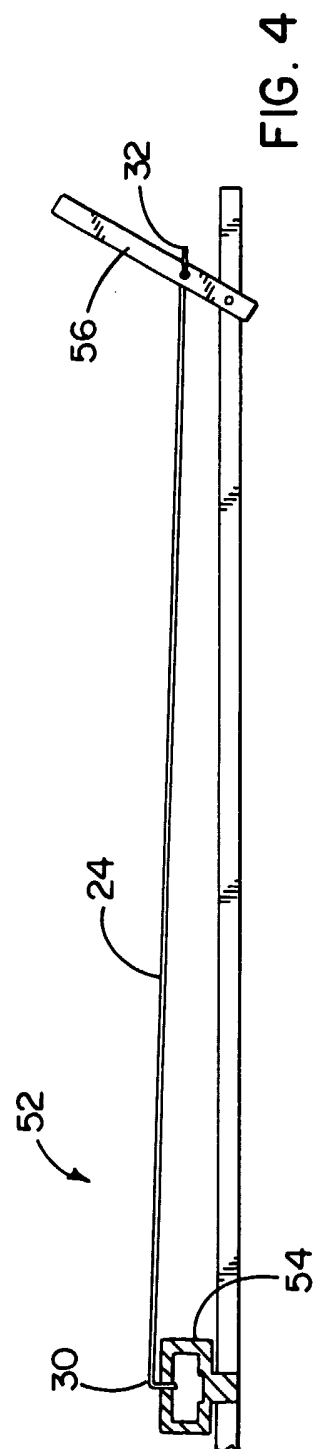
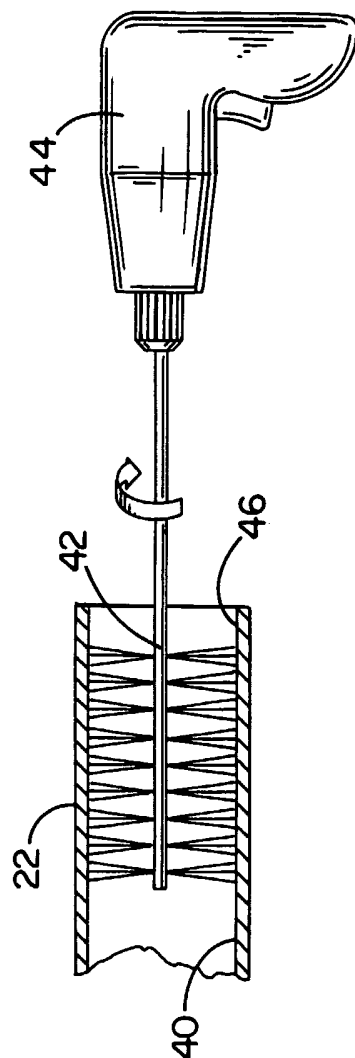
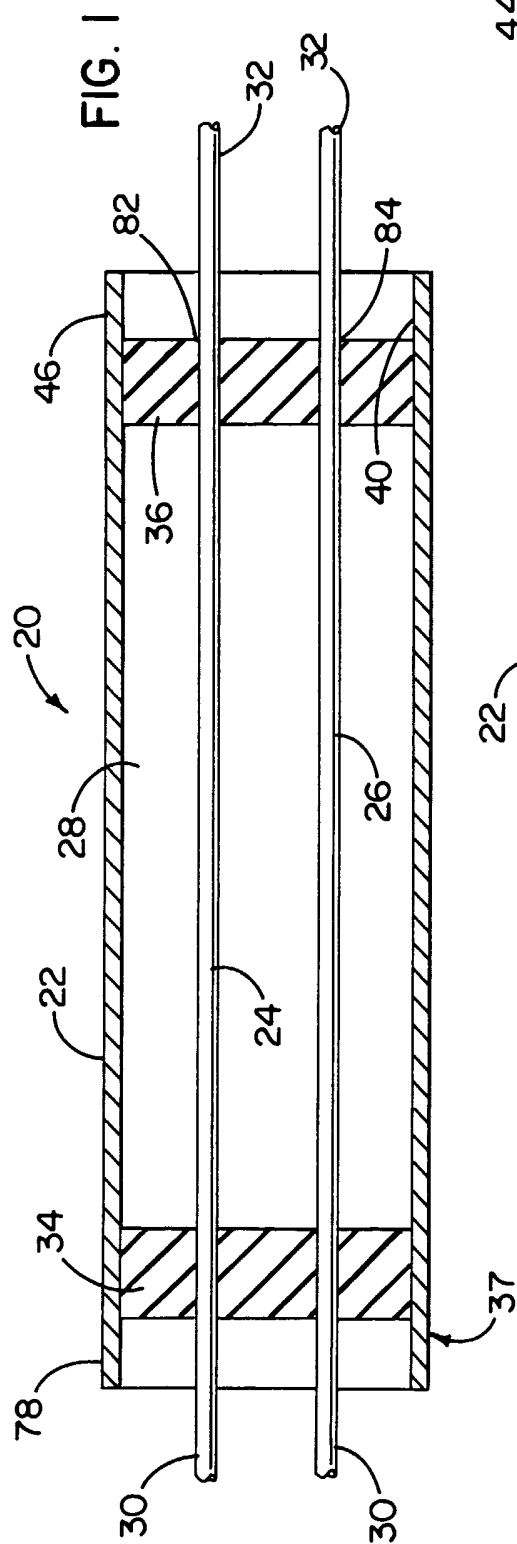
26. The apparatus of claim 25, wherein the wire straightening device includes a vice adapted to hold one end of the thermocouple wire and a movable lever adapted to pull another end of the thermocouple wire against the vice.

27. The apparatus of claim 22, further including a cleaning apparatus adapted to clean an inner circumferential surface of the outer sheath.

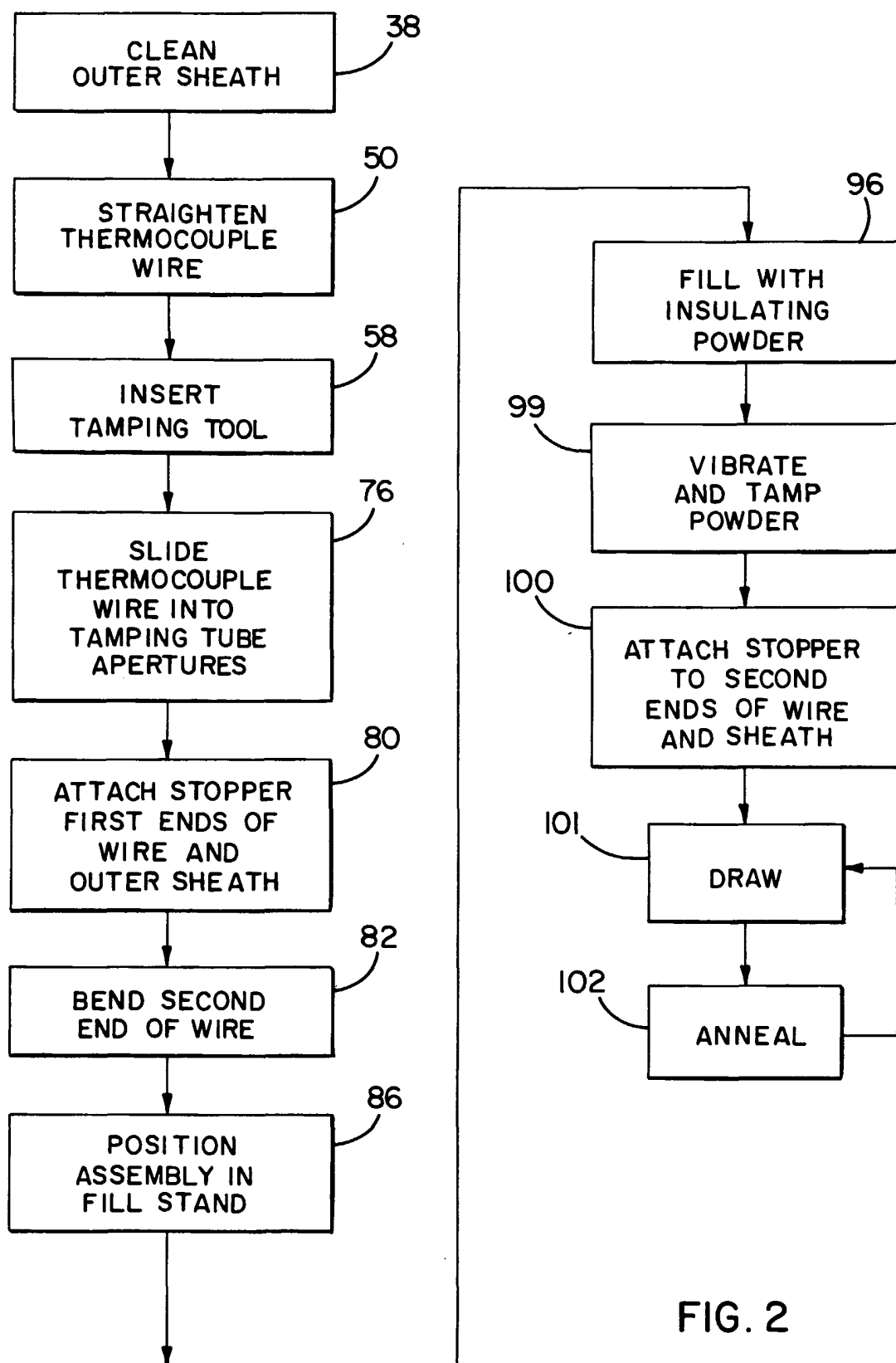
28. The apparatus of claim 27, wherein the cleaning apparatus is a rotatable brush.

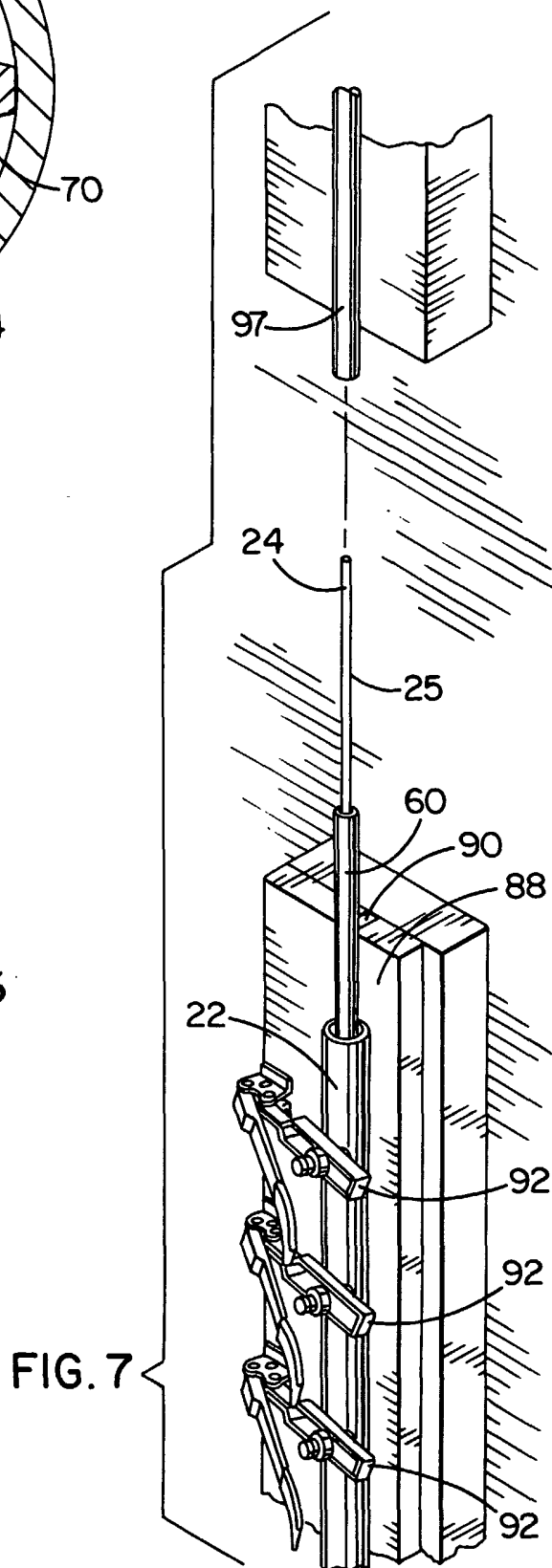
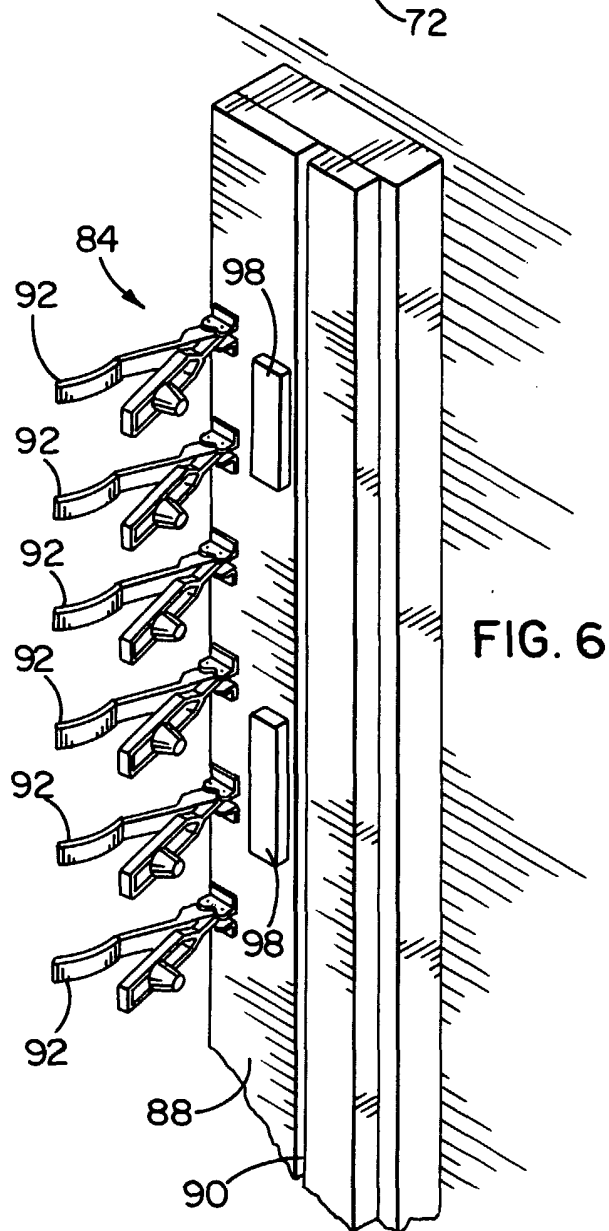
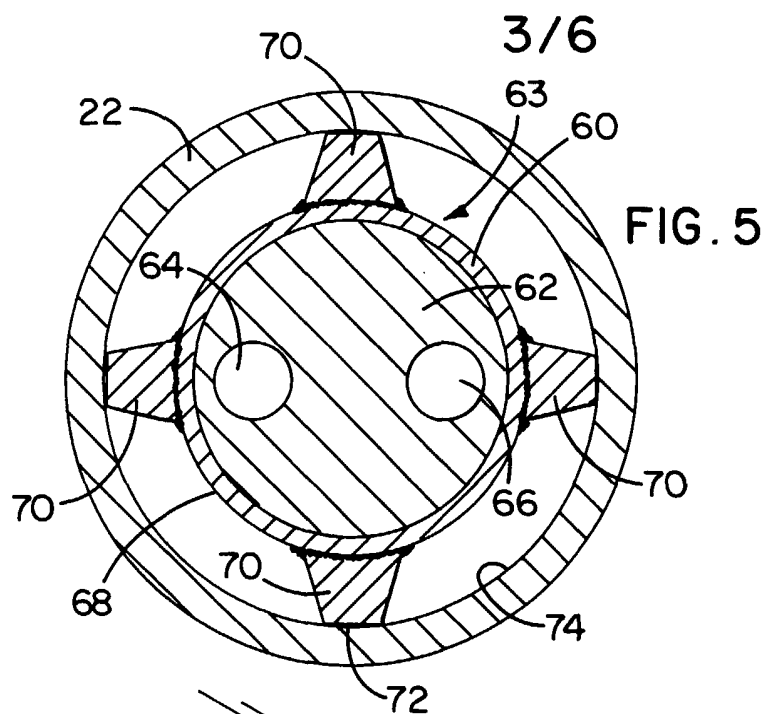
29. The apparatus of claim 22, wherein the tamping tube includes a substantially cylindrical rod, a substantially solid working end with first and second linear apertures extending through the working end, and a plurality of spacers extending from an exterior surface of the rod, the diameter of the tamping tube being slightly less than an inner diameter of the outer sheath.

30. The apparatus of claim 22, wherein the fill stand includes a substantially flat vertical surface with at least one groove for receipt of the outer sheath therein.



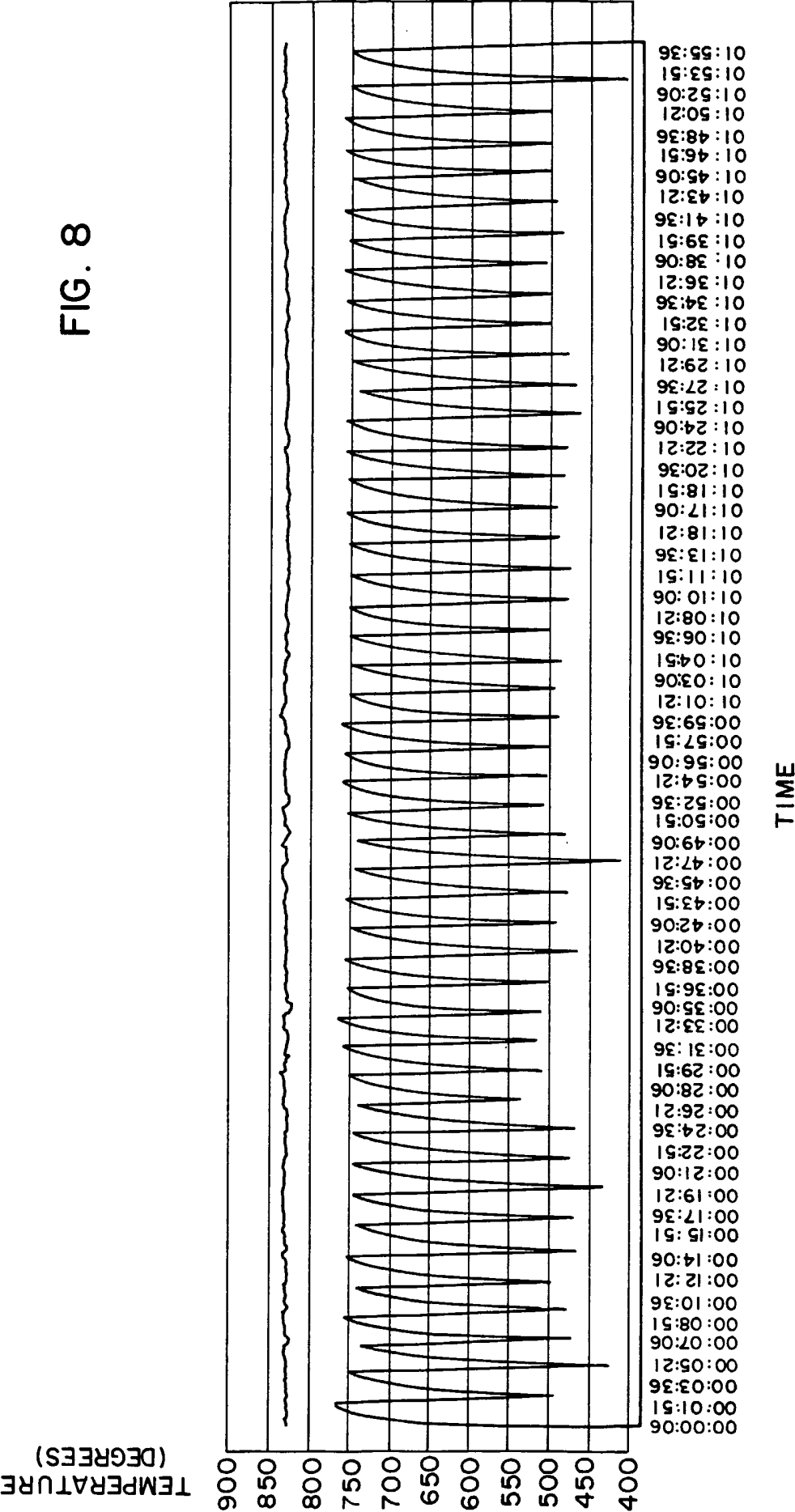
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4/6

FIG. 8



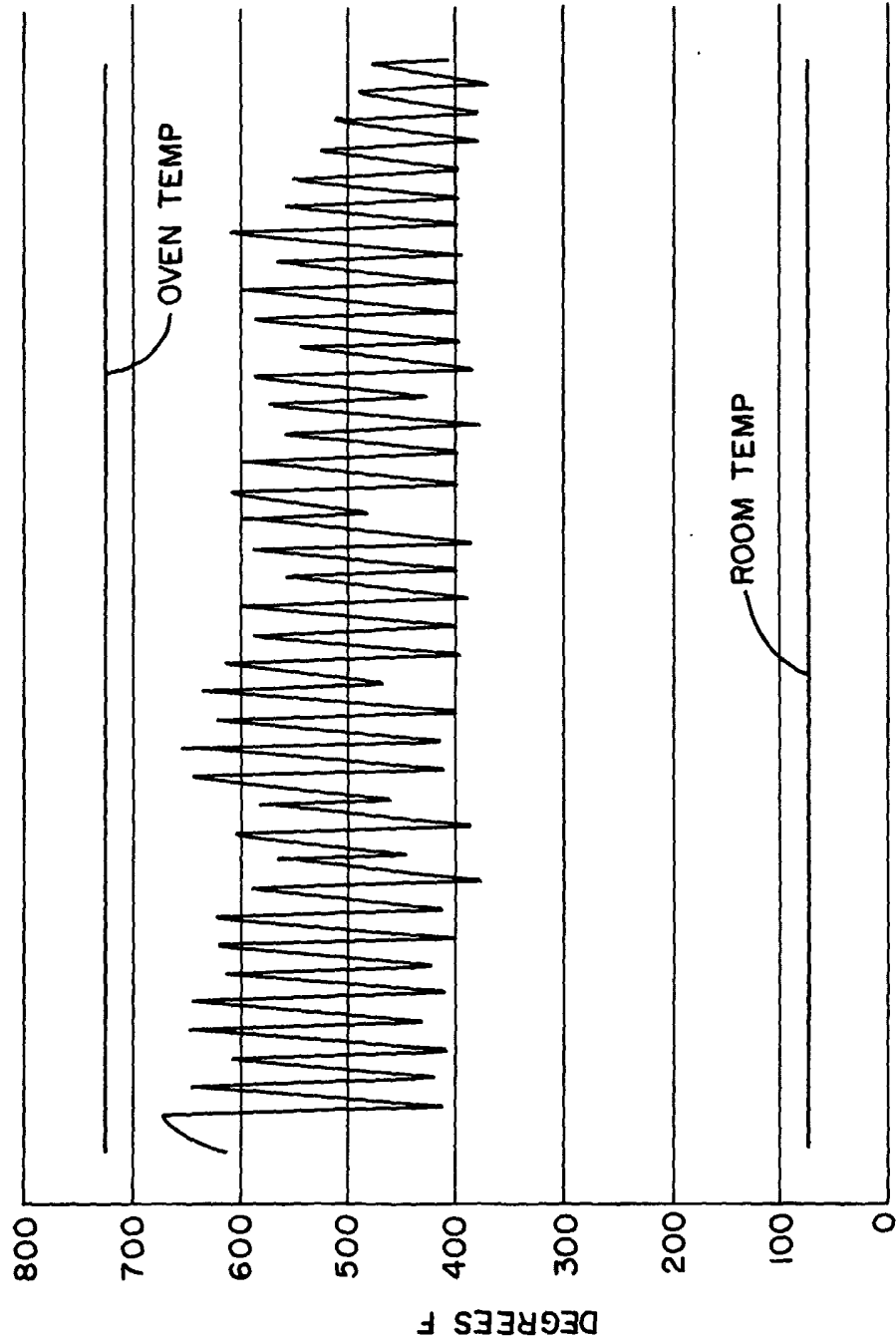


FIG. 9

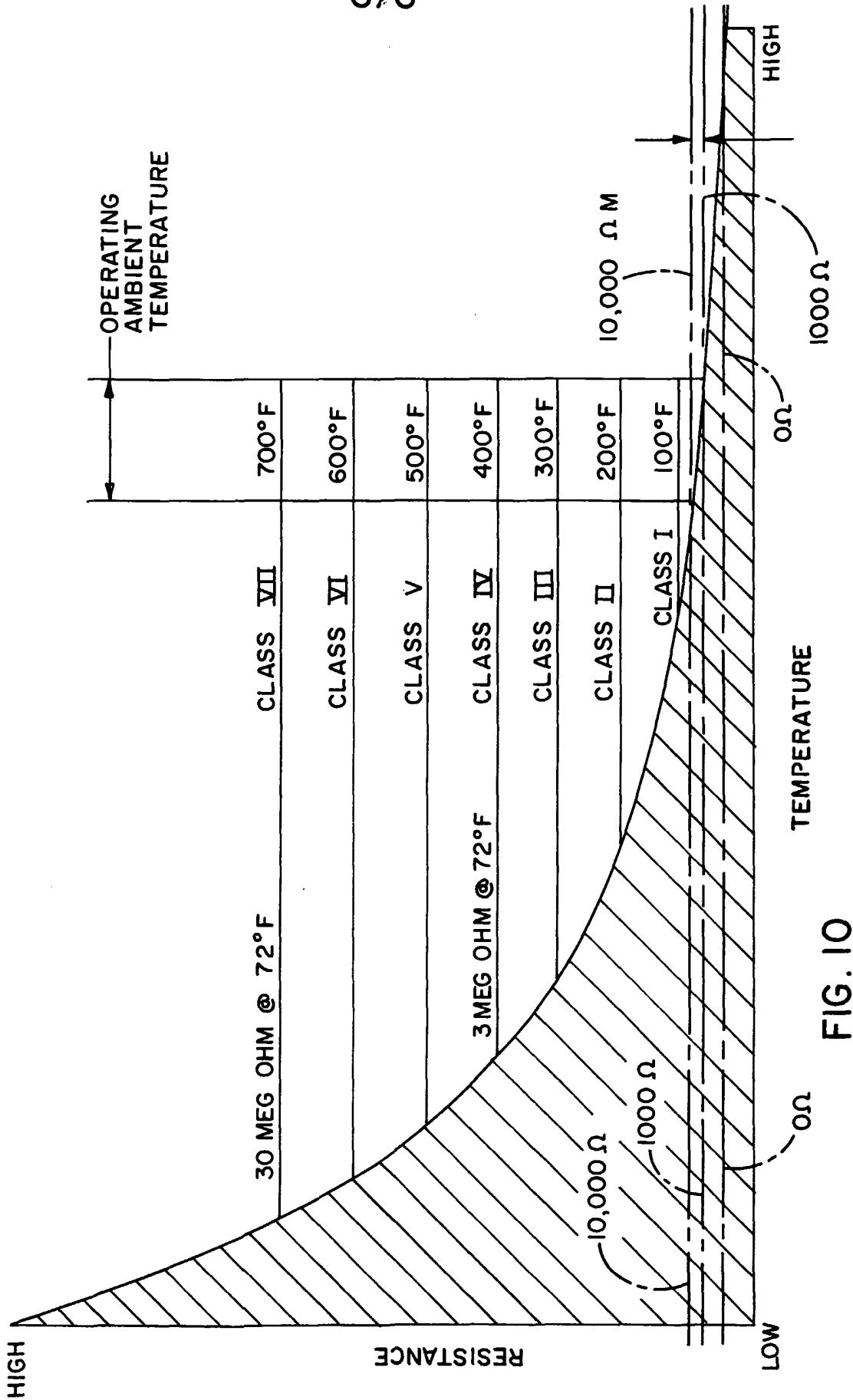


FIG. 10

INTERNATIONAL SEARCH REPORT

In Application No
PCT/US 01/29629

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 G01K7/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 7 G01K H01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 069 752 A (SHERNING OLUF D) 25 December 1962 (1962-12-25)	1,2,6-8, 16,17, 21,22,29
A	column 2, line 5 - line 40 column 3, line 21	3
A	US 3 737 997 A (DAVIS B) 12 June 1973 (1973-06-12) cited in the application the whole document	1,15,18, 21,27
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☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Int al Application No

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