

Sept. 25, 1962

T. S. TE VELDE
HEAT FLOWMETER AND PROCESS AND DEVICE FOR
THE PRODUCTION THEREOF
Filed Oct. 28, 1958

3,055,965

Fig. 1.

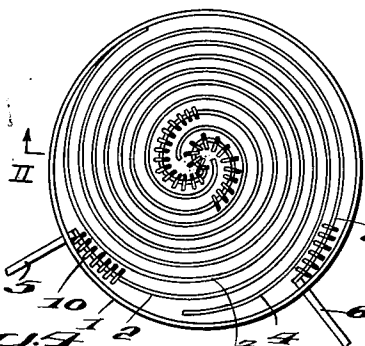


Fig. 2.

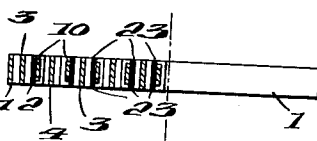


Fig. 4.

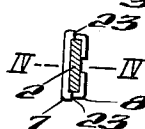


Fig. 3.

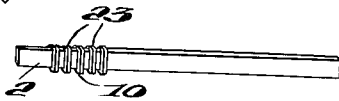


Fig. 5.

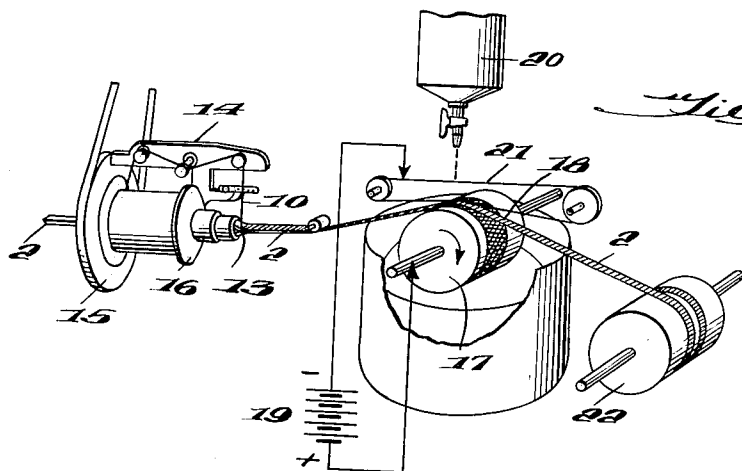


Fig. 6.

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HEAT FLOWMETER AND PROCESS AND DEVICE FOR THE PRODUCTION THEREOF

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Filed Oct. 28, 1958, Ser. No. 770,203

Claims priority, application Netherlands Oct. 30, 1957
7 Claims. (Cl. 136—89)

The invention relates to a heat flowmeter containing a great number of thermoelements connected in series, which have been wound on a bearer of insulating material, by winding a metal wire round a band of insulating material and coating half of each turn of said metal wire with a thermoelectrically dissimilar metal, and to a process and device for the production thereof.

Heat flowmeters, containing a large number of thermoelements connected in series, wound on a bearer of insulating material and, if desired, placed in a plate or sheet of an insulating synthetic resin, are known.

In these known heat flowmeters the elements generally consist of a helix of constantan wire, one half of each winding of said helix having been copper coated electrolytically or chemically.

In the known process for producing these elements one half of each winding is protected with a layer of wax or lacquer, the other half being subsequently electroplated, after which the layer of wax is removed.

The layer of wax should be provided very carefully on these windings in such a way, that the junctions of the couples co-operate, which is a tedious and elaborate process especially for a large number of very small thermocouples.

In the co-pending application Serial No. 707,534 of January 7, 1958 a heat flowmeter is described containing a large number of thermoelements wound into a helix wherein each turn of the helix has e.g. a rectangular shape.

Approx. 600 elements could be placed in the heat flowmeter per cm.² of surface; the sensitivity is then approx. 1 mv. for a heat flowmeter with copper constant and elements at a heatflow density of 50 kcal./hour m.² through a plate of 1 cm.².

It is the main object of the present invention to provide for a method for producing heat flowmeters of even greater sensitivity by a simple process. Other objects and advantages will be apparent from the following detailed description.

The process of the invention comprises winding a metal wire as a helix on a pliable flat core of insulating material, thereafter electroplating of all the turns of said helix the parts lying on one side of said flat core, so that about one half of each turn is plated and the joints of plated and unplated sections are situated substantially on the edges of the flat core, by pressing one flat side of said core with said helix on and against a body having a porous surface, said porous surface being impregnated with a solution of a salt of a metal thermoelectrically dissimilar to that of the helix and electrodepositing by direct current through the said helix and said solution on the parts of all the turns of said helix situated on that flat side of the core contacting the solution in said porous surface a layer of said thermoelectrically dissimilar metal.

Preferably the solution impregnated surface layer is mounted on a metal cylinder, rotatable around a horizontal shaft, so that on rotating the cylinder the surface layer is alternately soaked with the solution present in a container under the rotating cylinder and contacted with the helix, pressed against the top of the rotating cylinder. Preferably the core with the helix moves at the

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place of contact with the cylinder with substantially the same speed as the rotation velocity of the surface of the cylinder, so that on this place of contact the turns of the helix do not move with respect to the impregnated surface layer.

Preferably said core with said helix is pressed on and against said impregnated surface layer with a co-moving conductive endless string to which the negative pole of a direct current source may be connected.

The positive pole of said current source may be connected to said metal cylinder.

It has been found to be possible to coat with this process a constantan wire with a diameter of 0.02 mm. and wound with a pitch of 0.13 mm. on an insulating band, for example consisting of Teflon, 2 mm. wide and 0.125 mm. thick, for one half with copper without it being necessary to provide the other half with a layer of wax or lacquer with the difficulties connected therewith, whilst the "junctions" were lying on the edges of the band.

The tape-shaped heat flowmeter according to the process of the invention can e.g. be rolled up and taken up between one or more bands of an insulating material, to form a sheet containing approximately 1500 elements per cm.².

For the purpose of reinforcement and finish this plate can be pressed into a ring of a synthetic resin, for example of Teflon.

It is possible still further to reduce the dimensions of the constantan wire, the pitch of the windings and also the dimensions of the band to a considerable extent without the occurrence of difficulties in this process.

In this way heat flowmeters with 3000 and more elements per cm.² were made. Thus, in a round disc with a diameter of 1 cm., more than 2250 thermoelements can be placed, as a result of which the sensitivity of such a flowmeter containing copper constantan elements is 1 mv. at a heatflow density of 10 kcal./hour/m.².

The helix may be of any material which is thermoelectrically dissimilar to the material of the coating. For the electrolytical coating of the said helix metals such as e.g. platinum, gold, silver, iridium, palladium, rhenium, rhodium, chromium, iron, nickel, cobalt, copper, cadmium, zinc and tin can be used.

The following combinations of metals can be used to advantage: platinum on a platinum-rhodium alloy, gold on a gold-palladium alloy, iridium on an iridium-rhodium alloy, nickel on a nickel-chromium alloy, nickel-copper, copper-nickel, copper-constantan, silver-constantan, iron-constantan, wherein the last-mentioned metal of the combination always represents the metal of the helix.

In the accompanying drawings:

FIGURE 1 shows a view of an embodiment of a heat flowmeter according to the invention.

FIGURE 2 is a cross-section through this meter taken on the line II—II of FIGURE 1.

FIGURE 3 presents, on an enlarged scale, a section through the band of synthetic resin with on it a single turn of the helix in front view, which helix forms the thermoelements connected in series.

FIGURE 4 is a section through this turn taken on the line IV—IV in FIGURE 3 on an even more enlarged scale.

FIGURE 5 shows a heat flowmeter according to the invention comprising the band of synthetic resin with the helix forming a number of thermoelements connected in series, also on an enlarged scale.

FIGURE 6 is a diagram of the apparatus with which these heat flowmeters are made.

In FIGURE 1 and FIGURE 2 reference numeral 1 indicates a ring of synthetic resin with a bifilar band of synthetic resin 2 which has been rolled up and which has been pressed into the ring of synthetic resin, on

which band there is a constantan wire 10 which is coppered over half of its turns and is placed between two bands of synthetic resin 3 and 4. In the figures the junctions between the coated and uncoated parts are indicated by reference numeral 23.

It is possible to provide a lacquer or another insulating layer to the helix, by which the bands of synthetic resin 3 and 4 can be left out.

The terminals 5 and 6 can be mounted directly on the helix.

In FIGURE 3 it is indicated that the part 7 of each turn is coppered; the copper surface is indicated in FIGURE 4 by reference numeral 12, the constantan surface by 11.

FIGURE 6 shows how the helixes are mounted on the band of synthetic resin and how they are subsequently coppered.

Teflon can be taken for the insulating bands of the heat flow-meter; band of another insulating substance as e.g. a synthetic resin or a silicon can, however, also be used for the same purpose.

The apparatus for the production of the helixes shown in FIGURE 6 comprises a head 13. The constantan wire 10 is wound from the supply-coil 16 onto the band of synthetic resin 2 by means of the rotating arm 14, mounted on the driven disc 15.

Subsequently one half of each turn is coppered galvanically; to that end the band of synthetic resin 2 with the wire 10, is led over a gauze of textile cloth 18, said gauze being impregnated with a metal salt solution dripping from a container 20. The gauze is mounted on a rotatable cylinder 17, which is connected with the positive pole of the voltage source 19.

The endless wire 21 is connected with the negative pole of the voltage source 19 and presses the band 2 with the wire 10 on the gauze 18.

The band with thermoelements thus obtained is wound on a driven reel 22.

It is also possible to provide the band with a helix of another metal or another alloy and to provide this helix with still another metal so that each turn of said helix forms a suitable thermoelement.

If the bearer is not desired for one reason or another it can be dissolved. The heat flowmeter then consists of a helix of thermoelements which can or cannot be mounted between 2 sheets.

I claim:

1. A heat flowmeter comprising a helix of a metal wire wound on a band-shaped bearer of an insulating synthetic resin, wherein about one half of each turn of said helix is coated with a surface layer of a metal thermoelectrically dissimilar to that of the helix and all the junctions of coated and uncoated parts of the turns lie substantially on the edges of said bearer and wherein said metal helix with said bearer is coiled up spirally forming a sheet containing at least 1500 turns of said helix per cm.² and wherein said junctions lie on both sides on the surfaces of the sheet and wherein said turns of the helix are prevented from contacting each other by an insulating material.

2. A heat flowmeter according to claim 1, wherein said insulating material is a lacquer coating on the turns of the helix.

3. A heat flowmeter according to claim 1, wherein said insulating material is at least one band of an insulating synthetic resin between the turns of the spirally coiled up helix.

4. A heat flowmeter according to claim 1, wherein said sheet is fastened in a ring of synthetic resin.

5. A heat flowmeter according to claim 1, in which said sheet and said ring are covered by a film of a synthetic resin.

6. A heat flowmeter comprising a helix of a metal wire wound on a band-shaped bearer of an insulating synthetic resin, wherein about one half of each turn of said helix is coated with a surface layer of a metal thermoelectrically dissimilar to that of the helix and all the junctions of the coated and the uncoated parts of the turns lie substantially on the edges of said bearer and wherein said metal helix with said bearer is coiled into a bifilar spiral forming a sheet containing at least 1500 turns of said helix per cm.² and wherein said junctions lie on both sides on the surfaces of the sheet and wherein said turns of the helix are prevented from contacting each other by an insulating material.

7. A heat flowmeter comprising a helix of constantan wire wound on a band-shaped bearer of an insulating synthetic resin, wherein about one half of each turn of said helix is coated with a surface layer of copper and all the junctions of the coated and the uncoated parts of the turns lie substantially on the edges of said band-shaped bearer and wherein said helix with said bearer is coiled up spirally, forming a sheet containing at least 1500 turns of said helix per cm.² and wherein said junctions lie on both sides on the surfaces of the sheet and wherein said turns of the helix are prevented from contacting each other by at least one band of an insulating synthetic resin between the turns of the spirally coiled-up helix and wherein said sheet of spirally coiled-up helix with said bearer is fastened in a ring of a synthetic resin and wherein said sheet and said ring are covered by a film of a synthetic resin.

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