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(54) Resistance heaters.

(57) A resistance heater for performing heat treatment of the braze-affected area of a metallic sleeve attached by brazing within and to a metallic tube, consisting of a composite in generally tubular form and able to be inserted within the sleeve so as to register with that length of the sleeve over which it is desired to effect heat treatment, the composite including a cylindrical core (2), a ceramic tube (6) fitted over the core (2), at least one thermocouple (9) disposed in a slot (8) in the tube (6), a heater tube (10) fitted over the tube (6) and having over part of its length (the heating part) a spiral groove (11) extending right through the tube (10) thickness, the groove (11) being filled with high resistance material to provide heating when current is applied across the ends of the groove (11), and a further tubular part (14) extending over the non-heating part of the heater tube (10). The heating tube (10) is varied in thickness to give a desired temperature profile over the length of the sleeve being heat treated.

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Resistance Heaters

This invention relates to resistance heaters.

In particular, the invention relates to resistance heaters which have an important though not exclusive application to the heat treatment of metallic members which have undergone other operations which can affect metallurgical properties. One example of such a metallic member is a sleeve employed to repair a breach in a tube/tube plate weld of a heat exchanger by being secured in the relevant tube in a position to bridge the breach. The securing may be an explosive weld of one end of the sleeve to the bore of the tube plate, and a braze joint of the other end of the sleeve to the relevant tube. It is necessary to heat treat the sleeve after the making of the joints in order to restore the necessary properties to the braze-affected joints so as to ensure that design life can be expected. The braze is effected at a temperature of the order of 1150°C for about four minutes and the braze bond is typically about 40mm in length. Heat treatment however is at a lower temperature of the order of 750°C but for a longer period, typically one hour. A longer portion than the braze needs to be treated however, typically 150mm.

The braze heating is performed in one preferred system by an induction probe inserted within the sleeve and accessed from the tube plate bore. However, such probes pose problems of adequate cooling and are expensive. Employment of such probes for heat treatment with its lower temperature and longer period would be wasteful.

According to the invention, heat treatment of the braze-affected area of a metallic sleeve attached by brazing within and to a metallic tube is performed by a resistance heater inserted within the sleeve so as to register with the length of the sleeve over which it is desired to effect heat treatment. The said heater is preferably a composite in generally tubular form and may include at least one thermocouple by means of which the temperature for heat treatment can be monitored so that control over temperature can be effected by variation of the electric current supplied to the heater. In order to provide an effective temperature profile over the length to which heat treatment is applied, the thickness of a part of a composite may be varied. A preferred way of doing this will be subsequently described. The invention also includes resistance heaters constructed to provide a desired length and profile of heat treatment to be applied to a tubular metallic member.

In a typical example, to be applied to the heat treatment as aforesaid of a breach-bridging sleeve of a stainless steel over a length of say 115mm at say $750^{\circ}C \pm 25^{\circ}C$ for say one hour, a typical resistance heater is shown in the accompanying drawings, wherein:

Figure 1 is an elevation of the heater, and

Figure 2 is an enlarged view in section of part of Figure 1.

Referring to the drawings we provide a resistance heater 1 which is a composite of a number of parts which will now be described. There is a cylindrical core member 2 of a high resistance Ni/Cr alloy such as KANTHAL or NICHROME (RTM) screw threaded at one end 3 and with a bush 4 also of KANTHAL or NICHROME welded to the other end at 5. Over the member 2 is fitted a ceramic (eg alumina) tube 6 which abuts the bush 4 at one end and is engaged at the other end by a nut 7 on the member 2. There is a longitudinal slot 8 (see Figure 2) in the tube 6 for reception of a thermocouple 9 which is cemented in position. In a modification, not shown, there is another longitudinal slot disposed in diametrically opposed relationship to the slot 8, enabling another thermocouple to be installed to give a check on the correct operation of the first one.

Over the ceramic tube 6 is fitted a heater tube 10 of KANTHAL or NICHROME which has over a portion 16 thereof a spiral groove extending through the full thickness of the tube 10 and typically 1mm wide on a pitch of 5mm, the groove 11 after assembly with the core member 2 and ceramic tube 6 being filled with cement of high electrical resistance. The profile of the tube 10, produced by machining with constant bore, is such that there is a part 16' of maximum diameter thickness situated at the outer end of grooved portion 16 and welded to bush 4, and there is also a cylindrical, ie non-grooved, portion 13 which is of maximum constant diameter thickness and which is carried in a metallic (eg stainless steel) tubular part 14 via a heat conducting sleeve 15 secured by cementing to both parts (see Figure 2).

The grooved portion 16 of the heated tube 10 projects from the part 14 and is only partially coverd by two diametrically opposed part-annular bimetallic strips or wings 17 welded to the main body of part 14 and which terminate short of the outer end of portion 16. The grooved portion 16 of tube 10 diverges to maximum diameter thickness, corresponding with that of cylindrical portion 13, at a position 18 in register with the outer ends of the strips or wings 17. It tapers in both directions from this position, in one direction to terminate at its outer end and in the other direction to a step where the portion 14 begins. There is a bracket 19 welded to the end of portion 13 of tube 10 which projects from the non-winged end of tubular part 14. The thermocouple 9 leads to circuitry 20 for monitoring.

In operation, cemented groove 11 of the heater tube 10 functions to provide a spiral of resistance heater material so that the tube 10 functions as a resistance heating element, the resulting heating effect being profiled along the grooved length of portion 16 by virtue of the varying thickness thereof as aforesaid.

Current is applied at bush 4 to the central core member 2 and returns via the grooved length of tube 10 to leave at the bush end thereof. The thermocouple 8 functions as the hot junction and is in good heat contact with the bimetallic strips or wings 17 since it is cemented in ceramic tube 6 which is in contact with heater tube 10 which is in contact with tubular part 14 via conducting sleeve 15 and the strips or wings 17 are welded to part 14. The strips or wings 17 are caused, when heat is generated in tube 10, to move outwardly to make firm contact with the breach-bridging sleeve aforesaid, thereby enabling the temperature of that sleeve to be constantly monitored by the thermocouple 8 so that the amount of heat generated by the tube 10 can be adjusted by varying the electric current supplied thereto so as to ensure that optimum conditions for the required heat treatment are provided.

The association of a bimetallic strip carried by a heater with a thermocouple hot junction, the bimetallic strip being caused, on heating, to move into contact with the wall of a tube into which the heater is inserted, is the subject of our copending application No 82 33335, filed 23 November 1982. That application discloses that the heater has two bimetallic strips at diametrically opposed positions so that temperature are measured across a diameter of the tube, this being capable of being used to check uniformity of temperature or provide a check of correct operating of the hot junctions, a large difference of temperature measurement indicating either a faulty hot junction or a poor contact. Furthermore, it is disclosed that the bi-metals can be fitted into slots cut into the heater.

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CLAIMS

1. A process of heat treatment of the braze-affected area of a metallic sleeve attached by brazing within and to a metallic tube, characterised in that the process is performed by inserting a resistance heater within the sleeve so as to register with that length of the sleeve over which it is desired to effect that heat treatment, and operating the resistance heater in a manner and for a period such as to perform said heat treatment in a desired manner.

2. For performing heat treatment of a tubular metallic member a resistance heater characterised in that it consists of a composite in generally tubular form and includes as well as a resistance heating element at least one thermocouple for monitoring temperature, the composite being inserted with the tubular member.

3. A resistance heater according to claim 2, characterised in that the thickness of that part of the said composite which comprises the resistance heating element is varied so as to provide a temperature profile over the said length to which heat treatment is to be applied.

4. A resistance heater according to claim 3, characterised in that the composite includes a central conductor, an electrically insulating sleeve engaged thereover, a resistance heating element disposed over said sleeve and with a non-heating part at one end region covered by an outer casing, diametrically-opposed bimetallic strips secured to said casing and extending

along part of the length of the heating part of said heating element, and at least one thermocouple hot junction in thermal conductive contact with said bimetallic strips and located in a recess in said sleeve, said bimetallic strips being capable of moving outwardly under the influence of temperature so as to contact said tubular metallic member being heat treated and thereby monitor the temperature thereof, whereby the amount of heat generated by the heating element can be controlled so as to apply the heat treatment to said metallic tubular member in a desired manner.

5. A resistance heater according to claim 4, characterised in that the resistance heating element is a metallic tube with constant bore but with thickness tapering lengthwise in both directions from maximum at an intermediate region to minimum constituting the heating part of said element before reverting stepwise to maximum at one end region and at said non-heating part of said element, and a spiral groove through the whole thickness of said tube, the spiral groove being filled with material which is of high resistance and produces a heating effect which depend on the amount of current applied across the tube and said central conductor over which said tube is engaged.

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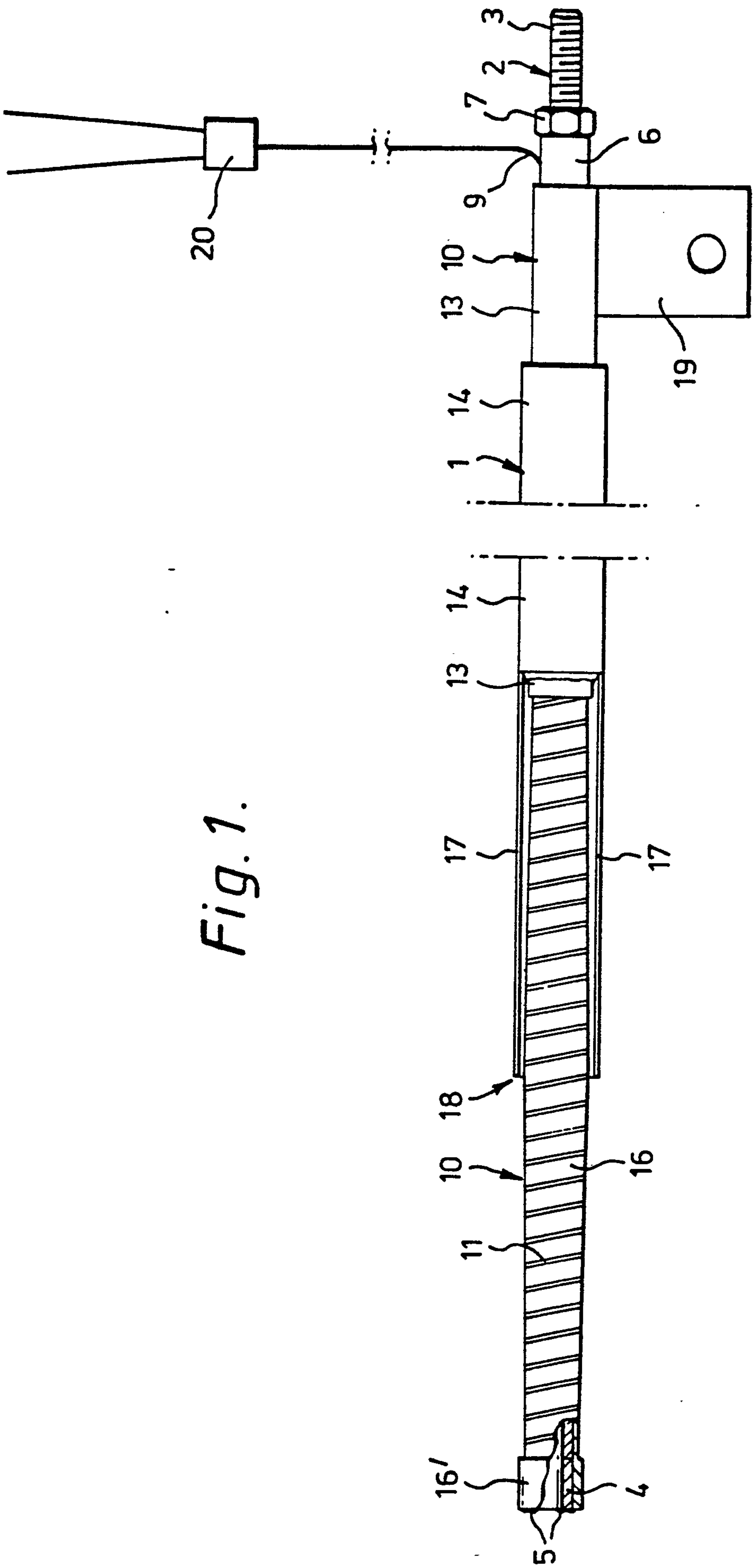

Fig. 1.

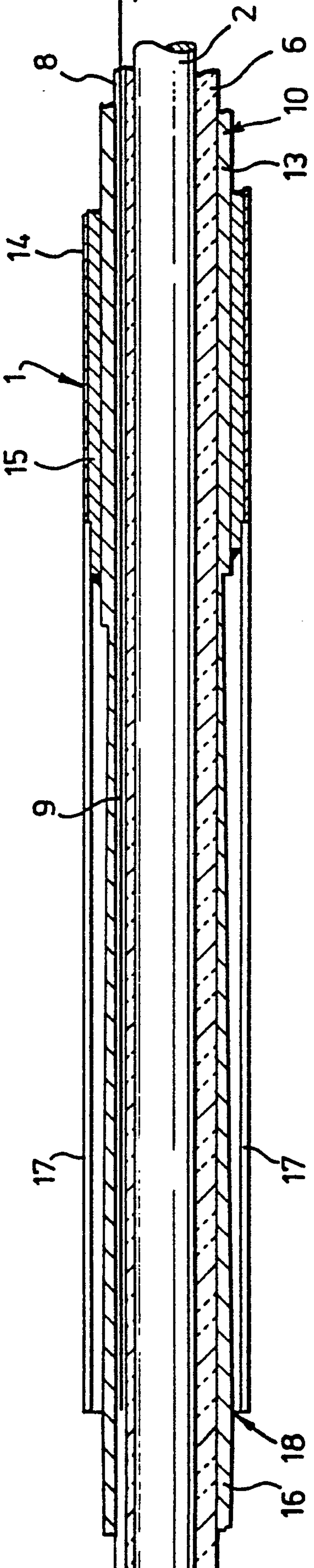

Fig. 2.

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Application number

European Patent Office

EUROPEAN SEARCH REPORT

EP 83307064.2

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
A	DE - B - 1 015 159 (SIEMENS) * Fig. * --	1,2,4,5	H 05 B 3/44 B 23 K 1/04
A	FR - A - 1 404 105 (ATELIERS DE CONSTRUCTION) * Fig. * --	1,2,5	
A	GB - A - 2 021 369 (H. STEGMEIER) * Fig. 1 * --	2,4,5	
A	US - A - 1 553 342 (V.G. VAUGHAN) * Fig. 1,2 * --	2,4,5	
A	DE - B - 1 101 638 (CONTINENTAL ELEKTROINDUSTRIE) * Fig. * ----	2,4,5	TECHNICAL FIELDS SEARCHED (Int. Cl. ³) H 05 B 1/00 H 05 B 3/00 H 05 B 6/00 B 23 K 1/00 B 23 K 3/00 B 23 K 13/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	28-02-1984	TSILIDIS

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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