United States Patent [19]

Heuel et al.

[11] **3,927,301**

[45] **Dec. 16, 1975**

[54] **ELECTRICAL HEATING CARTRIDGE**

[75] Inventors: **Otto Heuel; Heinz Emmerichs,** both of Ludenscheid, Germany

[73] Assignee: **HASCO-Normalien Hasenclever & Co.,** Ludenscheid, Germany

[22] Filed: **Sept. 17, 1974**

[21] Appl. No.: **506,888**

[30] **Foreign Application Priority Data**

Sept. 19, 1973 Germany 2347090

[52] **U.S. Cl.**................ **219/523;** 174/52 R; 219/526; 219/536; 338/218

[51] **Int. Cl.²** **H05B 3/06**

[58] **Field of Search** .... 219/201, 205, 335, 523, 219/526, 530, 536, 544, 552, 553; 338/218; 29/451; 165/185; 174/52 R, 65 R, 86

[56] **References Cited**

UNITED STATES PATENTS

1,416,897	5/1922	Simon	219/523
2,371,696	3/1945	Levitt	338/218 X
2,499,961	3/1950	Lennox	338/218 X
2,623,978	12/1952	Cantrell	219/526 X
2,913,987	11/1959	Clymer	174/86 X
3,096,426	7/1963	Axelson	219/538 X
3,213,263	10/1965	Steenbergen	219/205
3,335,459	8/1967	Tyrner	219/523 X
3,412,231	11/1968	McElligott	219/201
3,461,275	8/1969	Poole	219/553
3,761,601	9/1973	Kaesser et al.	174/52 R

FOREIGN PATENTS OR APPLICATIONS

136,169	1/1934	Austria	219/523
238,475	5/1961	Australia	219/523
671,734	5/1952	United Kingdom	219/523

Primary Examiner—Volodymyr Y. Mayewsky
Attorney, Agent, or Firm—Ernest G. Montague; Karl F. Ross; Herbert Dubno

[57] **ABSTRACT**

A heating cartridge insertable into a bore of a body to be heated comprises a slightly tapering metallic shell whose larger end is cylindrical and carries a thread coupling sleeve freely rotatable thereon. A coil of resistance wire within the shell has turns more widely spaced at the center than at its ends to provide a more uniform heating effect.

4 Claims, 4 Drawing Figures

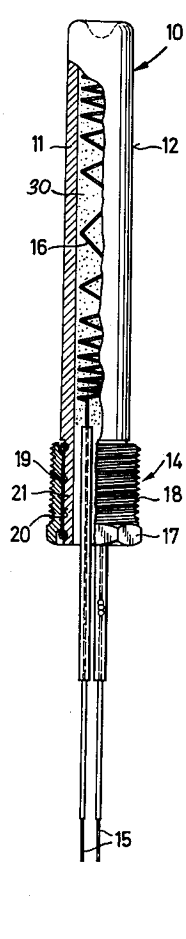


Fig.1

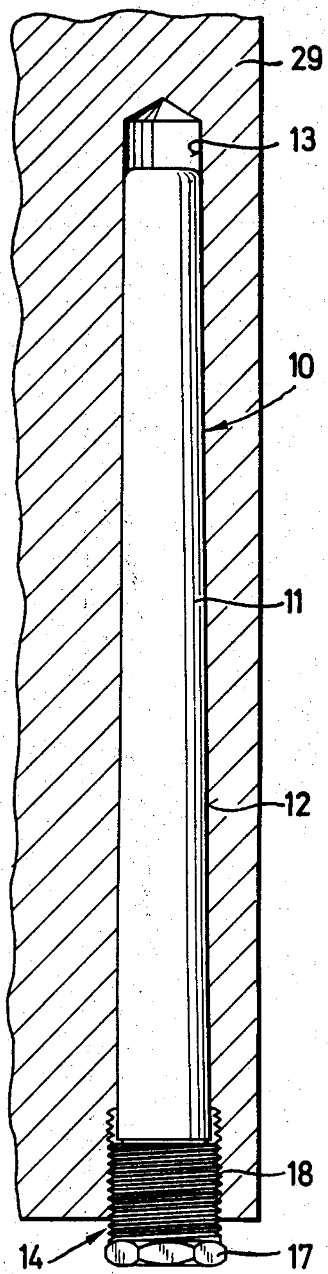
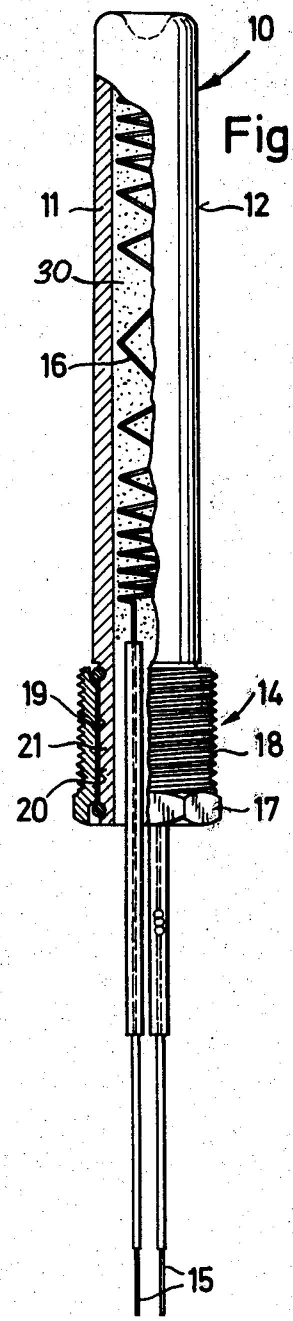


Fig.2



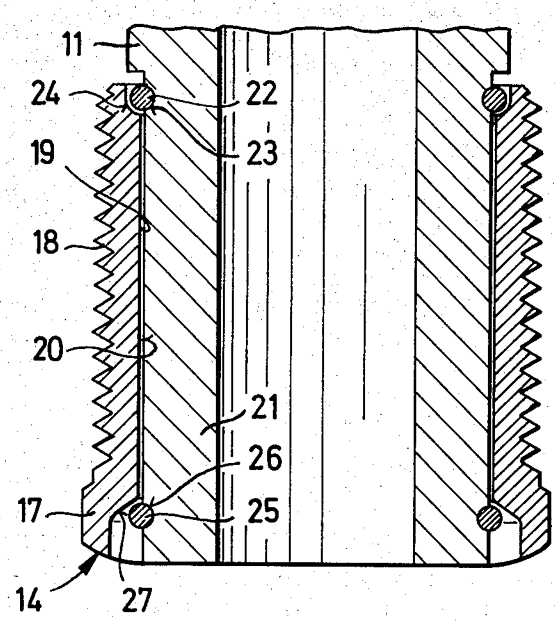

11
24
22
23
19
18
20
21
26
17
25
14
27

Fig.3

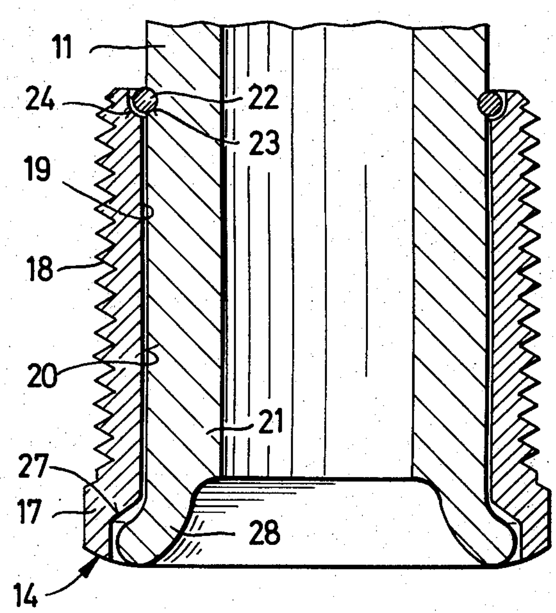

11
24
22
23
19
18
20
21
27
17
28
14

Fig. 4

ELECTRICAL HEATING CARTRIDGE

FIELD OF THE INVENTION

Our present invention relates to a resistive heating element insertable into a thermally conductive body of a machine tool or other equipment to be held at a desired temperature.

BACKGROUND OF THE INVENTION

Heating elements of the type described are commercially obtainable in various versions. They are used in particular where a controlled and localized heating effect is desired, e.g. in the processing of synthetic resins by injection, compression or extrusion.

Conventional heating cartridges generally comprise a cylindrical shell, usually of a high-grade alloy steel, enclosing a helical resistance wire serving to convert electrical energy into heat. A threaded coupling at the supply end of the shell enables the heating cartridge to be screwed into a corresponding threaded bore of the body to be heated.

Important criteria to be considered in such a heater are its service life and the efficiency of energy conversion. To optimize these criteria, the manufacturing processes, the choice of materials and the techniques of assembly of such units have been progressively refined. Thus, excessive play between the outer shell surface of the cartridge and the bore receiving same is detrimental to its service life and efficiency. This means that the assembly tolerances are to be kept as small as possible, which requires very careful machining of both the shell and the corresponding bore.

OBJECTS OF THE INVENTION

The general object of our invention, therefore, is to provide an improved heating cartridge in which the aforestated requirements of close fit and good heat transfer are largely satisfied.

A more particular object is to provide means in such a cartridge for enabling it to be conveniently secured to any body which is to be heated thereby.

It is also an object of our invention to provide a heater construction substantially equalizing the heating effect over the entire cartridge surface.

SUMMARY OF THE INVENTION

In accordance with an important feature of our invention, the cartridge has a thermally conductive shell whose outer surface deviates from the conventional cylindrical configuration by tapering slightly from a first or bottom end to a second or top end, thereby insuring a secure seating of the shell in a bore of complementary frustoconical shape despite unavoidable manufacturing tolerances. A conicity on the order of 50:1 has been found highly satisfactory.

Since the shell may have to be inserted to a greater or lesser extent into the bore, depending upon the aforementioned tolerances, another feature of our invention resides in the provision of a coupling affording the desired flexibility without subjecting the cartridge body to any objectionable stress. Such a coupling comprises an externally threaded cylindrical sleeve fitted onto a cylindrical extremity of the shell at its bottom end, the sleeve being freely rotatable on that extremity and being held in position by axial abutments such as a pair of split rings or one split ring and a fixed collar or flange on the shell. Advantageously, an annular clearance is left between the inner sleeve surface and the cylindrical surface of the shell extremity to compensate for possible axial disalignments between the coupling sleeve (or its seat in the bore) and the shell (or bore) axis. The free-wheeling of the sleeve on the shell prevents any rotary entrainment of the latter during mounting or extraction of the cartridge and thus avoids frictional damage.

We have found that the usual heating coil, with constant axial spacing of its helical wire turns, does not afford uniform heat distribution since the heating effect is more concentrated at the longitudinal center of the cartridge than at its ends. Therefore, pursuant to another important feature of this invention, we prefer to make the density of the helicoidal wire turns relatively low at mid-length and relatively high at the ends, for the purpose of substantially equalizing their heating effect. This feature is particularly advantageous in conjunction with the close-fitting frustoconical shell described above since in that case the heat on the outer shell surface passes directly into the surrounding body, with no intervening air cushion providing a certain leveling effect.

BRIEF DESCRIPTION OF THE DRAWING

The above and other features of our invention will now be described in detail with reference to the accompanying drawing in which:

FIG. **1** is a somewhat schematic elevational view of our improved heating cartridge inserted into the body of a workpiece;

FIG. **2** is a similar view of such a cartridge, shown partly in longitudinal section;

FIG. **3** is a longitudinal sectional view of the lower extremity of the heating cartridge, drawn to a larger scale and illustrating the mounting of a coupling sleeve; and

FIG. **4** is a view similar to FIG. **3**, showing a modified sleeve mounting.

SPECIFIC DESCRIPTION

A heating element or cartridge **10**, shown in FIGS. **1** and **2**, has a slightly frustoconical metallic shell **11** tapering from its bottom end to its top. The shell **11** fits closely within a similarly tapering bore **13** of a workpiece body **29** to which the cartridge **10** is attached within bore **13** by means of an externally threaded coupling sleeve **14** as illustrated in FIG. **1**. Sleeve **14** is freely rotatable on shell **10** as more fully described below with reference to FIGS. **3** and **4**.

FIG. **2** shown a pair of leads **15** supplying current to a coil **16** of resistance wire imbedded in an insulating mass **30** within shell **11**. The thickness of this shell decreases progressively from its bottom to its top, its inner peripheral wall being of substantially cylindrical shape. Shell **11** could also be of uniform thickness, in which case the space accommodating the coil **16** would be frustoconical.

The density of the helicoidal turns of coil **16** varies over its length and is lowest at its longitudinal center, increasing progressively toward both ends. This arrangement is designed to provide more uniform heat distribution along the surface of cartridge **10**.

Sleeve **14** terminates in a hexagonal head **17**, engageable by a wrench, and carries male threads **18** mating with corresponding female threads in the bore **13** of workpiece or support **29**. The smooth inner sleeve surface **19** has a slightly larger diameter than the confronting outer surface **20** of the cylindrical lower extremity **21** of shell **11**, thus defining therewith a narrow annular clearance to facilitate correction of any disalighment between the axes of the frustocone and the threads in either the cartridge **10** or the bore **13**.

FIG. **3** shows the mounting of sleeve **14** on the lower, heavier end of shell **11** by means of two split rings **22**, **25** seated in a pair of axially spaced annular grooves **23** of the shell and in internal annular recesses **24** and **27** of the sleeve. This mode of mounting enables the replacement of the sleeve on the cartridge, e.g. for insertion of the latter into a different workpiece, or use of the same sleeve to retain a replacement cartridge in the body **29**.

FIG. **4** shows a modified sleeve mounting with replacement of the lower split ring **25** by a peripheral flange **28** at the bottom end of shell extremity **21**. With this structurally simpler arrangement the sleeve **14** can be mounted or detached only by way of the upper end of the shell **11**.

The conicity of the mating surfaces of shell **11** and bore **13**, i.e. the cotangent of half the vertex angle of the frustocone, is advantageously about 50:1; such tapers can be easily machined with commonly available tools.

We claim:

1. A heating cartridge comprising:

a thermally conductive shell having a frustoconical outer surface tapering from a larger end to a smaller end thereof with a conicity on the order of 50:1, said shell being closed at said smaller end and being provided at said larger end with a cylindrically tubular extremity;

a pair of axially spaced-apart, substantially nondeformable annular abutments on the outer surface of said extremity;

an externally threaded rigid sleeve freely rotatable on said extremity between said abutments in an axially fixed relative position, said sleeve having an inner diameter slightly exceeding the outer diameter of said extremity whereby an annular clearance is formed between said extremity and said sleeve;

a heating coil insulatedly received in said shell and provided with a supply lead passing through said shell and provided with a supply lead passing through said extremity; and

a thermally conductive dielectric mass in the interior of said shell, said heating coil consisting of resistance wire imbedded in said mass.

2. A heating cartridge as defined in claim **1** wherein said coil has helicoidal turns more closely spaced at the ends of said coil than at mid-length thereof.

3. A heating cartridge as defined in claim **1** wherein at least one of said abutments is a split ring received in a peripheral groove of said extremity.

4. A heating cartridge as defined in claim **3** wherein the other of said abutments is a peripheral flange integral with said extremity.

* * * * *