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(12) # EUROPEAN PATENT APPLICATION

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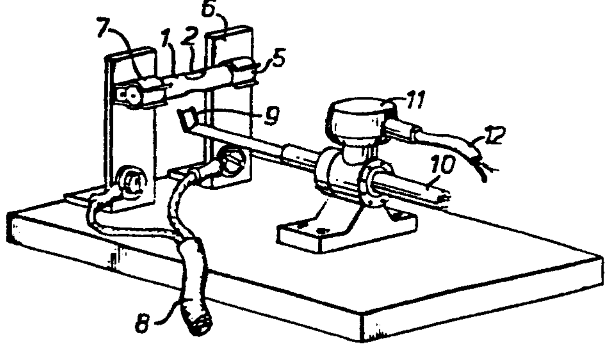
(54) **Igniter.**

(57) An igniter (7) for gas or oil fuelled boilers and other appliances uses a carbon cored silicon carbide or other ceramic monofilament as a heating element.

FIG. 3



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IGNITER

FIELD OF THE INVENTION

The invention relates to fuel-ignition in heating boilers or other domestic or industrial gas or oil fuelled appliances.

BACKGROUND

We have sought alternatives to the electronic and piezo-electric spark ignition systems now widely used in gas cookers, domestic central heating boilers and similar gas equipment, and to resistance-heated rod igniters that have been proposed but not to our knowledge used, at least in the United Kingdom. Our aim has been an igniter that is not unduly position sensitive in equipment so that design and layout are not restricted, that allows an energy input sufficiently high to give positive and reliable ignition with natural gas, that works at voltages and powers safe and easily provided by inexpensive means, and that is easily serviced by gas and heating fitters. We have also sought to meet the standard requirement that ignition times of 2 to 5 seconds and preferably 3 seconds or less shall be attainable, and also that in domestic equipment a power rating of 10 watts or less at suitable voltages such as the standard 24 volts for many control units shall be used. Rod igniters of silicon carbide cannot meet these requirements, being used at mains voltage with high power requirements, and any attempt to scale down the conventional ceramic techniques by which they are made gives bodies that are too fragile to use.

Among published prior proposals are:-

Jeidel Austrian specification 71645 (1916)
Auergesellschaft GmbH German ALS 1 133 842 (1959)
Carborundum Co. German OLS 1 629 895 (1967)
" German OLS 2 501 894 (UK 1 497 871)(1975)

None of the prior art proposals meet the difficult task of simultaneously satisfying the criteria we have given above, for gas ignition primarily but also for oil.

THE PRESENT INVENTION

We however have found successful a fuel-ignition device comprising an electrically conductive carbide, boride, silicide, nitride, oxide or other ceramic monofilament as a heating element and means for passing a heating current tothe filament to raise it to fuel-ignition temperature.

The filaments on which the success of the invention depends are made for example, by vapour deposition onto a preformed core or by drawing from a melt, and show a high tensile strength, up to 340 Kg/mm^2 in one particular silicon carbide filament we have tested. Such strengths may be contrasted with typical strengths below 10 Kg/mm^2 for ceramic bodies made by conventional ceramic techniques such as extrusion of plastic mixes, pressing,tamping and the like, whether or not followed by final machining stages.

To provide for ready conduction of current in the cold, and guard against a surge of current as the filament warms up from ambient temperature, the filament desirably has a more conductive core of carbon or of tungsten or other metal. A carbon core is preferred, on which for example silicon carbide, the preferred ceramic, is readily vapour deposited.

Silicon carbide filaments are produced for example for reinforcement purposes in composite materials, and one particular filament that is suitable for the present purpose is produced by continuous vapour deposition of β-silicon carbide on a carbon filament core, final diameter 140 microns. Such a filament is strong enough to stand repeated thermal cycling from room temperature to over 1100°C in ignition, as well as mechanical shocks to which equipment may be subjected.

The carbon core is important to the functioning the device. At low temperatures, the carbon core itself carries the bulk of the current due to the relatively high cold resistance of the surrounding silicon carbide. Similar solid or tungsten-core silicon carbide filaments require increased power compared to the carbon core filament to attain ignition temperature due to their higher cold resistances. Power requirements can be controlled by varying the filament diameter and in particular the cross-sectional ratio of carbon core to silicon carbide annulus.

In the installed device it is desirable for short ignition times that a continuous pre-heating current should be passed through the filament, when for example it is readily provided that the filament shall reach the ignition temperature in five seconds or less on passage of the heating current. The presence of a conductive core is desirable for passage of such a current, which for example may be 20-30 mA at 10-15V in the particular 140 micron carbon core silicon carbide filament described above. A suitable preheating current for given circumstances is readily found by experiment, though the filament temperature it corresponds to is not easily measured.

Ignition temperatures, readily measured by pyrometer observations, vary according to the conditions but sample figures for stoichiometric mixtures with air are:

Methane		650° - 750°C
Hydrogen	as indications of town gas ignition temperatures	570° - 600°C
Carbon monoxide		610° - 650°C

A suitable nominal filament temperature for ignition, as measured by the final filament temperature under a given power in still air, is readily established for given conditions of fuel/air flow, uniformity of mixing and temperature. It cannot be less than the ignition temperatures quoted above and for practical conditions is likely to be 1000°C or above and in any event not less than 800° or 900°C.

The mounting of the filament is preferably in a tubular or other disposable holder for impingement of a fuel/air flow on the filament. Preferably further the filament is retained in place by a crimped mounting of copper or other metal freely conductive of heat and electricity.

DETAILED DISCUSSION

In the following detailed discussion the filament is referred to as 'fibre'.

Initial tests were conducted by replacing the piezo-electric igniter of a natural gas cooker by a 15 mm length 21 of the 140 micron diameter fibre, clamped by simple terminal screws in a holder 22 and placed 30 mm from the gas orifice 23, across the path of the gas jet. The arrangement is shown in Fig. 1 of the accompanying drawings, the old igniter 24 being used as the gas source.

The terminals were then connected in a test circuit with a mains transformer (50 cycles), a voltmeter and an ammeter and a current of 250 mA at 40 volts applied. The fibre heated to 1180°C and gave ignition in less than a second.

In a similar test a fibre 1 cm long was used and gave satisfactory ignition at 24 volts. This fibre was then cycled repeatedly from room temperature to 1150°C, one second on and one second off. There was no treatment of the fibre ends to improve contact, but even under this simple test the fibre underwent 6360 cycles before failure, which occurred at the contacts.

A further 1 cm sample of the fibre was then tested for resistance at different temperatures. The resistance dropped from 260 ohms at 600°C (the lowest temperature used) to 155 ohms at 800°C and 140 ohms at 1000°C, and levelled off at 110 ohms at 1300°C, giving a valuable protection against overheating but a temperature sufficient to secure ignition in all reasonable circumstances (see Fig. 2). The cold resistance was 435 ohms.

This graph differs from that of β-SiC due to the role played by the carbon core.

In a second test application shown in Fig. 3 of the accompanying drawings, the igniter fibre itself is fitted in a small holder rather like a domestic fuse and equally easily replaceable. The holder consists of a ceramic tube 1 with opposed holes 2 for gas flow, and terminal caps 5 with solder connections 3 for the fibre 4. The holder is clipped at 7 into copper mountings 6 to which current supply wires 8 are fixed. Gas is directed onto the fibre by a burner nozzle 9 fed from a supply pipe 10 through a solenoid operated valve 11, the supply wires 12 of which are also shown.

To avoid any problems of melting of the solder at the terminals, other forms of terminal connections were also tested, in particular brazing, noble metal cements and mechanical fixing. Of these, the most satisfactory was crimping of the fibre into a copper capillary tube of outside diameter 1.46 mm and inside diameter 0.33 - 0.43 mm.

The copper tube was soldered into the fuse housing and tested using the same apparatus as described in Fig. 3.

<u>Test 1</u>

Initial Electrical Readings		Current 350 mA. Voltage 41V
Fibre length	20 mm	
Ignition Temperature	1200°C	
Power Cycle	2 seconds on 6 seconds off	
Time to Ignition	1 second	
No. of cycles before failure	10,125	

Final Electrical Readings - 330 mA, 47V.

Mode of failure - thinning down and eventual fracture of fibre due to oxidation.

Test 2

Electrical readings 36V 350 mA

Fibre length 22mm

Power Cycle 3 seconds on, 2 seconds off

Ignition Temperature 1600°C

Time to Ignition 1 second

No. of cycles before failure 771

Mode of failure - formation of a silica (SiO_2) bubble and eventual fracture of fibre due to rapid oxidation.

When the already heated fibre igniter is introduced into the natural gas flame, the temperature of the fibre increases by up to 200°C. Though this should theoretically enhance oxidation, and reduce the service life, it appears that the natural gas shroud about the igniter actually forms a protective barrier against oxidation.

In all the early tests, the emphasis was on thermal shock testing through rapid cycling. Though the fibre igniter itself has low thermal mass and as such dissipated most of its heat within the short 'off' periods of cycling, some residual heat was maintained, particularly by the surrounding connections and hence the igniter was not allowed to reach ambient temperature and hence its true high value of cold resistance. In a typical working environment, however, where say for a domestic gas cooker the igniter would be subjected to use only about a dozen times a day, it would be allowed to reach room temperature i.e. attain its original high cold resistance.

Cycling on this basis (30 minutes to 1 hour off period) showed a time delay prior to ignition (a slow power build up to overcome the cold resistance). The time delay, in the range 5 to 20 seconds, undesirable but is readily overcome by applying a constant low power current of for example 0.5 watt to maintain the temperature above ambient, e.g. at 200°C.

In practical application of the invention to a cooker one igniter in the centre of the hob can light a small auxiliary burner and flame tubes then light the main burners as required. A separate igniter is used for the oven.

CLAIMS

1. A fuel-ignition device comprising an electrically conductive carbide, boride, silicide, nitride, oxide or other ceramic monofilament as a heating element and means for passing a heating current to the filament to raise it to fuel-ignition temperature.

2. A device according to claim 1, in which the ceramic is in vapour-deposited form and on a pre-formed core.

3. A device according to claim 1 or 2, in which the ceramic is present on a tungsten or other metal, or carbon, core of higher electrical conductivity than the ceramic.

4. A device according to any preceding claim, in which the ceramic is silicon carbide.

5. A device according to any preceding claim wherein the filament is mounted in a tubular or other disposable holder for impingement of a fuel/air flow on the filament.

6. A device according to any preceding claim, wherein the filament is retained in place by a crimped mounting of copper or other conductive metal.

7. A device according to any preceding claim, further having means for passing a continuous pre-heating current to the filament to allow it to reach the ignition temperature in five seconds or less on passage of the heating current.

8. An ignition device substantially as herein described in relation to any one of the accompanying drawings.

9. A heating boiler or other domestic or industrial gas or oil fuelled appliance fitted with an ignition device according to any preceding claim.

FIG. 1

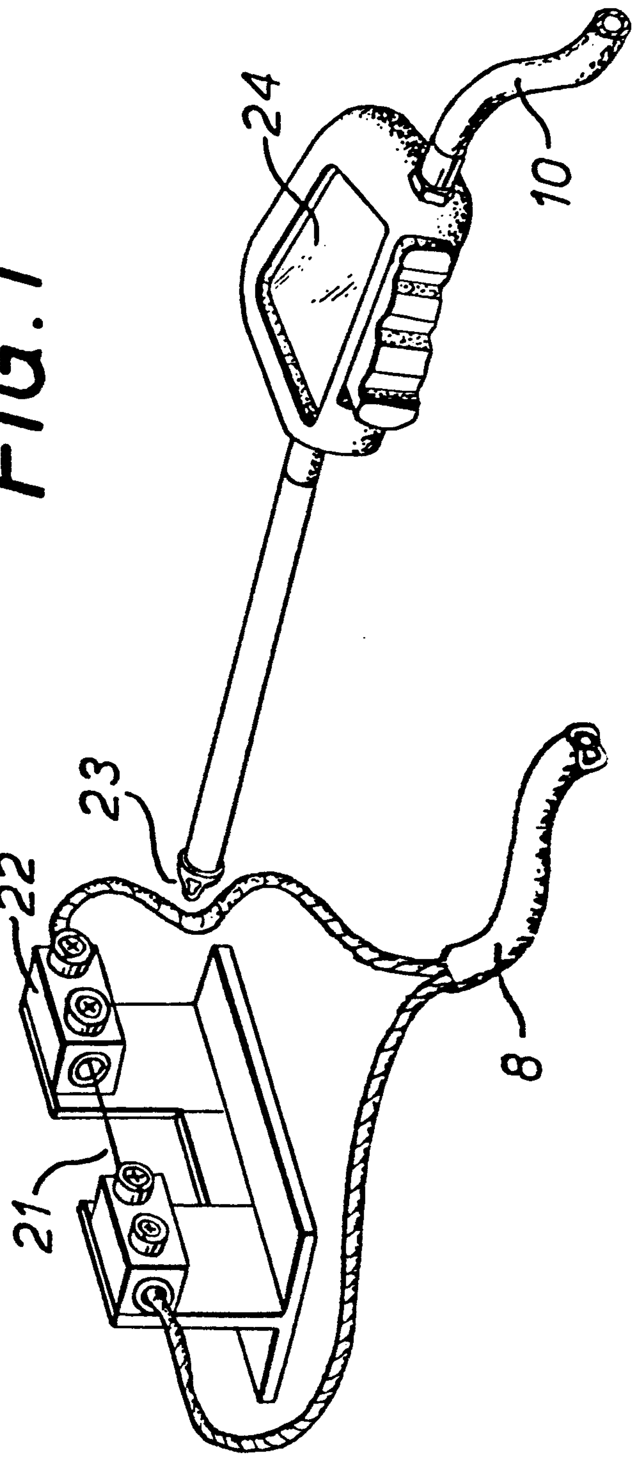


FIG. 2

SiC Fibre:- 1cm long

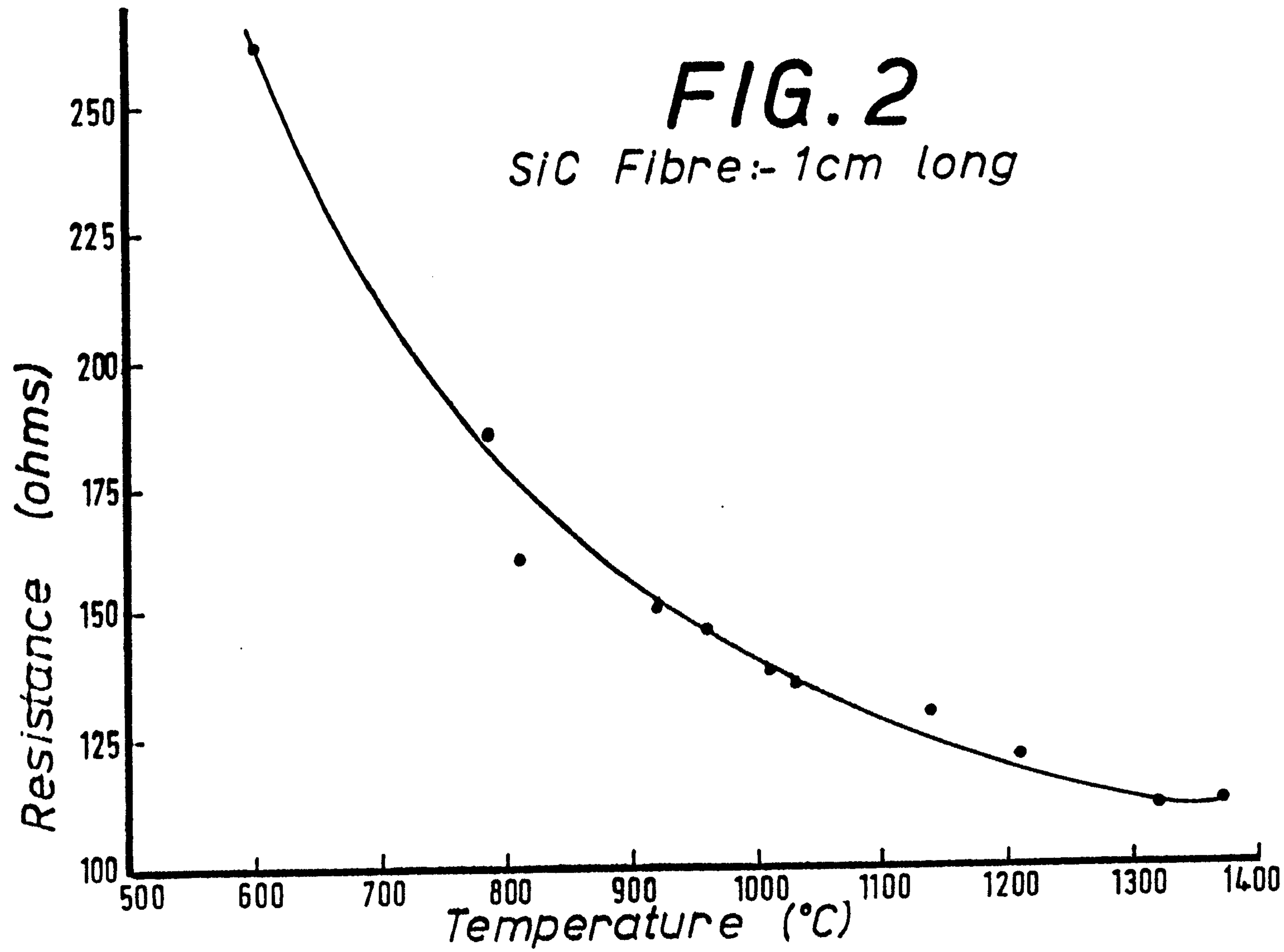


FIG. 4

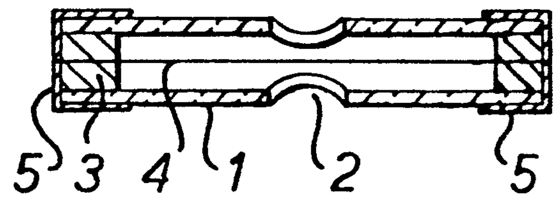
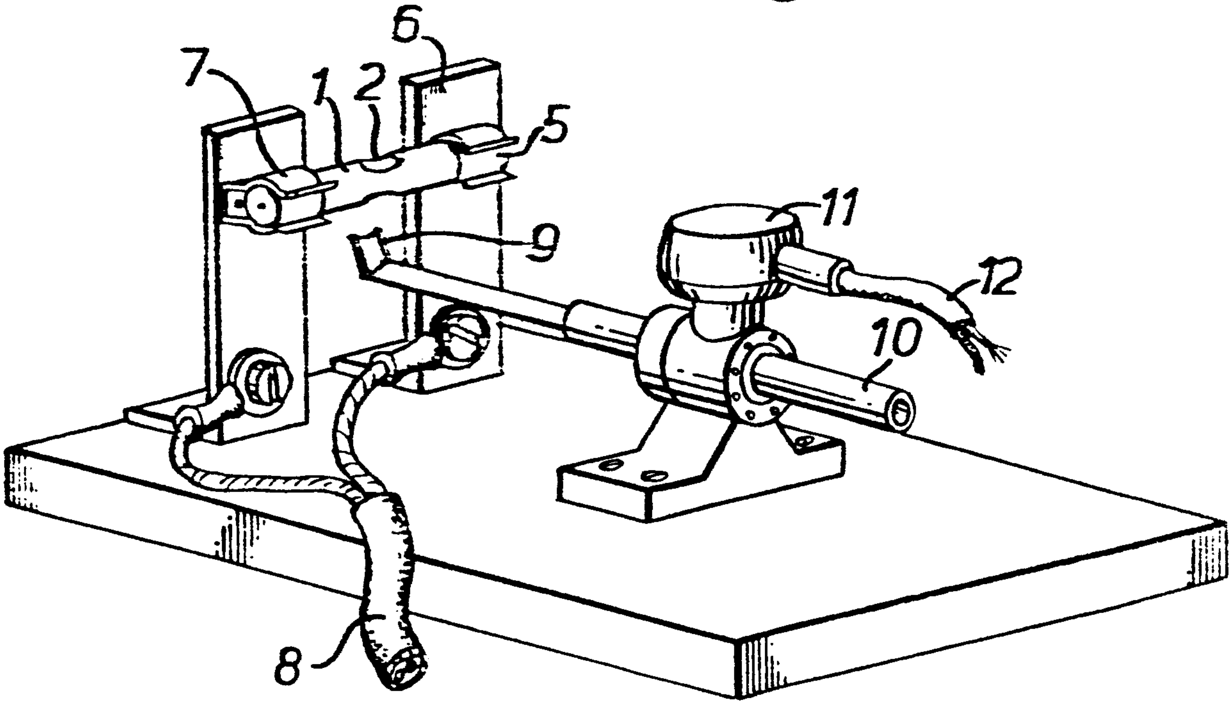


FIG. 3



European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 79 301 238.6

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	DE - B-1 238 126 (AKTIEBOLAGET KANTHAL) * complete document *	1,3, 4	F 24 C 3/10 F 24 C 5/14 F 23 Q 7/00 H 05 B 3/10
D	DE - B - 1 133 842 (AUERGESELLSCHAFT) * complete document *	1,2	
	US - A - 3 928 910 (PERL) * column 3, lines 27 to 50 *	2	
	GB - A - 1 377 525 (VOLCANO COMPANY) * fig. 1 *	5	TECHNICAL FIELDS SEARCHED (Int.Cl.3)
	FR - A - 2 176 596 (SOCIETE LES PILES WONDER) * fig. 1 and 2, positions 6a and 8b *	6	F 23 Q 7/00 F 24 C 3/00 F 24 C 5/00 H 05 B 3/00
	US - A - 3 372 305 (MIKULEC) * fig. 4 *	6	
A	DE - U - 1 930 018 (STROHMAIER) * fig. 5 *	5	
D	DE - A1 - 2 501 894 (THE CARBORUNDUM CO.) * complete document *		

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	28-09-1979	PIEPER