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SOME EXPERIMENTS WITH A DOMESTIC ELECTRIC FIRELIGHTER

by

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Summary

Experiments are described which show that paper and cotton cloth may be ignited in about three seconds by the invisible stream of hot air from a domestic electric firelighter and that ignition is possible up to about 6 in from the end of the nozzle. The nozzle and exposed parts of the barrel become sufficiently hot to ignite materials in contact with them and take a considerable time to cool after the heater has been switched off. It is concluded that great care should be exercised when using domestic electric firelighters and that they are unsuitable for use by elderly or infirm people and must be kept out of the hands of children.

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Introduction

Several makes of domestic electric firelighter are now available. Their principle of operation is that air is blown over an electric heating element and is raised to a sufficiently high temperature to ignite coal and similar fuels. It has been suggested that, although electric firelighters may be safe in normal use, they would be hazardous if accidentally overturned or displaced from the hearth or misused, particularly by children. The main dangers would then be the ignition of materials outside the grate and burns to the person either by the hot air stream or by direct contact with hot parts of the firelighter. Measurements were made with a typical firelighter to assess these hazards.

A diagram of the firelighter is shown in Fig.1. Part of the cool air from the fan passes through a ceramic tube containing the heating elements and out of the nozzle, part passes between the ceramic tube and the barrel to cool the barrel and part passes between the barrel and the heat shield to cool the heat shield. A thermostatic cut-out is provided which disconnects the heater supply should the fan fail or the nozzle become blocked.

Experiments carried out and results

All the experiments were carried out with the firelighter approximately horizontal and its barrel supported by a pile of bricks. Before starting an experiment time was allowed for the lighter to attain its maximum temperature.

The maximum temperature of the stream of hot air at various distances from the nozzle was measured using a 40 s.w.g. thermocouple. The results are given in Fig.2.

The temperatures attained by the barrel and nozzle were measured by 40 s.w.g. thermocouples attached to the points shown in Fig.1. The times taken for them to cool after the heater had been switched off, both with and without the fan running, were also measured. The results are given in Table 1.

Table 1

Temperatures attained by firelighters

Part of firelighter Fig.1	Maximum temperature °C	Time constant* min	
		Fan on	Fan off
Barrel	430	5	19
Nozzle	450	5	11

*The time constant is the time taken for the difference in temperature from the surroundings to change by 63 per cent of its initial value.

Experiments were carried out to find the times taken to ignite at various distances from the nozzle of paper, cotton cloth, wood and untreated fibre insulation board. Details of these materials are given in Table 2. The results are given in Table 3.

Table 2

Materials used in ignition experiments

Material	Thickness cm	Weight per unit area gm/cm	Density gm/cm^3
Whatman No.2 Filter Paper	0.0176	0.0087	-
Cotton Material (White)	0.0145	0.012	-
Deal	1.3	-	0.52
Fibre Insulation Board (Untreated)	2.5	-	0.26

Table 3

Ignition times of materials

Material	Distance from nozzle in.	Ignition times s				
		Individual values				Mean
Paper	1	3	4	4	4	3.8
	2	3	4	4	3.6	3.7
	3	5	6	5	5	5.3
	4	12	8	14	8	10.5
	5	No ignition				-
Cotton material	1	3	3	3.4	3	3.1
	2	3.4	3.6	3.6		3.5
	3	5	5			5
	4	17	15	18	21	18
	4½	No ignition				-
Wood	1	14	13			13.5
	3	19	17.4			18
	4	40	29	28	50	37
	4½	78	90			84
	5	380	172			c.300
Fibre Insulation Board	1	4				4
	3	6				6
	4	13				13
	5	41	72			57
	6	208				208
	7	No ignition				-

It was found that paper could be ignited in about 5 s if allowed to touch the hot nozzle while in the stream of cooling air from the barrel. This could be done for up to 80 s after switching off the heater.

A few cautious experiments indicated that the back of the hand could be held in the air stream about 1 in from the nozzle for of the order of $\frac{1}{4}$ s without feeling severe pain.

Discussion

Owing to radiation loss from the thermocouple the air stream temperature is likely to be underestimated, particularly at high values. The maximum measured temperatures were as high as those of many flames and thus the air stream, although invisible, would be expected to ignite materials and cause burns in the same way as small flames.

The ignition experiments showed that close to the nozzle thin cellulosic materials such as paper and cotton cloth will ignite in 3-4 s, untreated fibre insulation board will ignite in about the same time, while wood which is more difficult to ignite will do so in about $\frac{1}{4}$ min. There is a danger of the

ignition of cellulosic materials up to about 6 in from the end of the nozzle.

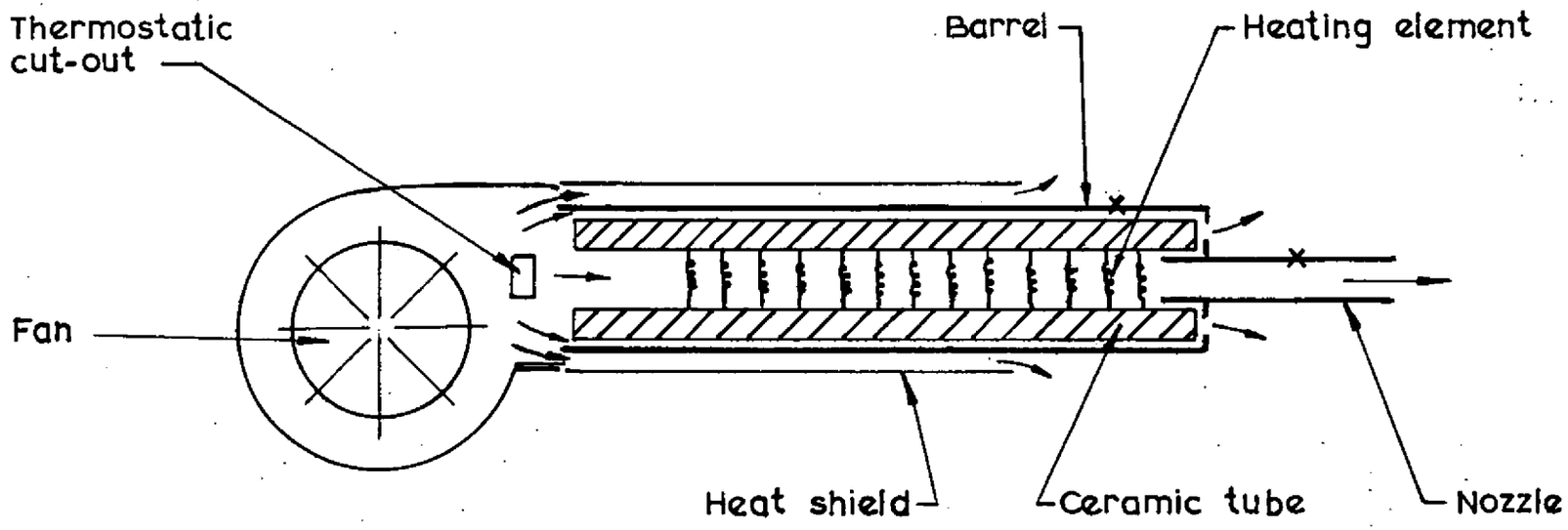
The temperatures of the barrel and nozzle were sufficiently high to cause ignition of many materials; even higher temperatures would probably be attained if the nozzle were inserted in a fuel bed. The stream of hot cooling air from the barrel was found to facilitate the ignition of materials in contact with the barrel and paper could be ignited in this way for as long as 80 s after switching off the heater. The time taken for the barrel to cool to 150°C, a temperature at which the possibility of its igniting materials may be discounted, was 5 min with the fan running and 20 min with it switched off. The lighter would not be safe to store away before this time had elapsed.

It is unlikely that a healthy and active person would be severely burnt by the hot air stream since he would have time to withdraw after feeling pain, but this does not apply to infants and old or infirm people. A burn would almost inevitably result if the hot barrel were touched. The greatest danger of burns occurs should clothing be ignited by the hot air stream or hot parts of the lighter. This could occur in 3 seconds.

Conclusions

The experiments confirm that the electric firelighter is a highly incendiary device, as it is intended to be. Since the hot air stream is invisible there is no indication of the extent of the space in front of the nozzle within which materials may be ignited. In addition there is a considerable area of exposed metal which becomes hot enough to cause burns or possibly ignite materials and this remains hot for some time after switching off the heater. The model used in these experiments was fitted with a key operated switch making inadvertant switching on difficult but which would not prevent misuse by children; the only positive indication that it was actually switched on was a slight noise from the fan and a glow visible only by looking directly (at several feet) into the nozzle. For these reasons it must be used with caution and intelligence above the level normally expected in the use of household equipment. Owing to the serious consequences which may follow ignition of clothing it is not suitable for use by elderly or infirm people and it must be kept out of the hands of children. It should never be switched on except when in position in the grate. Great care must be taken in its use to ensure that there is no likelihood of its being displaced from the grate, e.g. by catching one's feet in a trailing flex. Adequate cooling time must be allowed before putting away.

The hazards should be considerably reduced by fitting a switch which would turn off the heater unless the lighter were standing firmly on its base but, owing to the heat stored in the ligher, they would not be entirely eliminated.



x Points where thermocouples were attached

Not to scale

FIG.1. DIAGRAM OF FIRE LIGHTER

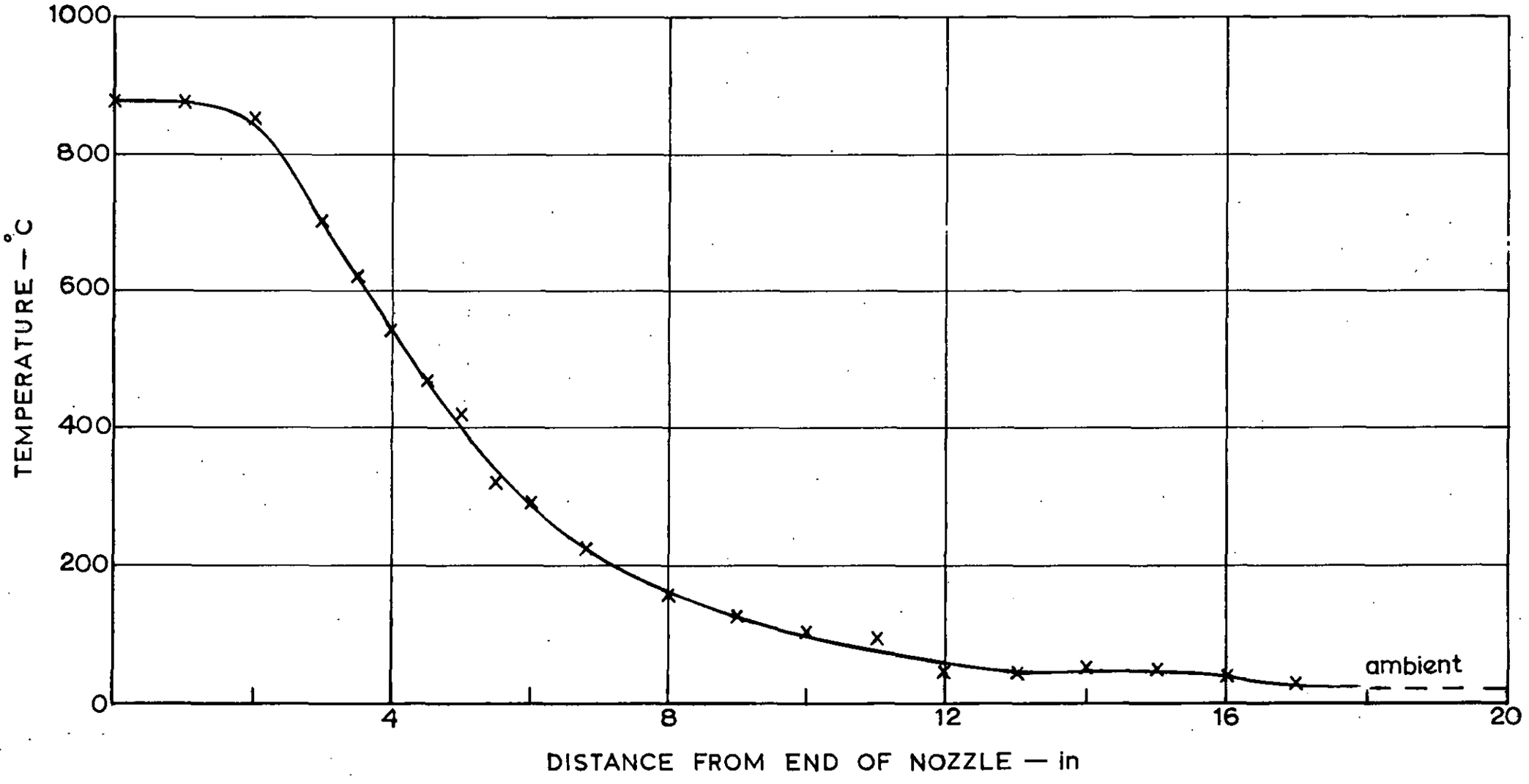


FIG.2. MAXIMUM TEMPERATURE OF HOT AIR STREAM