

F. R. Note No. 485

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE  
JOINT FIRE RESEARCH ORGANIZATION

This report has not been published and should be considered as confidential advance information. No reference should be made to it in any publication without the written consent of the Director, Fire Research Station, Boreham Wood, Herts. (Telephone: ELStree 1341 and 1797).

## FIRES ASSOCIATED WITH ELECTRICAL APPARATUSSES

## III COOKING APPLIANCES

by

Jane M. Mather

## SUMMARY

Fires occurring between September 1957 and October 1958, inclusive, in which the electric cooking appliances, cookers, fish fryers, kettles and toasters, were involved are examined in detail.

A regional pattern of fires involving electric cookers in dwellings is apparent.

Electric cookers are compared with gas cookers and several significant features are noted.

November 1961

Fire Research Station,  
Boreham Wood,  
HERTS.

# FIRES ASSOCIATED WITH ELECTRICAL APPARATUSES

## III COOKING APPLIANCES

by

Jane M. Mather

### 1. INTRODUCTION

A special survey of fires of electrical origin was undertaken during the period from September 1957 to August 1958 inclusive. This note examines the 1489 fires\* recorded in the cooking appliances group, which consists mainly of cookers but also includes portable hot-plates, fish fryers, kettles and toasters.

Fire incidence due to each source of origin is described in Table 1. Hot-plates have not been separated from cookers in any of the tables because when a fire has been reported as originating from a hot-plate it has not always been possible to determine whether the hot-plate was portable or whether it was part of a cooker.

Table 1

Fire incidence in relation to the originating electric appliance

(Electrical survey: September 1957 - August 1958)

Electric Appliance	Number of fires
Cooker	1379
Fish fryer	65
Kettle	39
Toaster	6
Total	1489

The fires originating from cookers and fish fryers have been analysed in two parts: according to whether the fire resulted from faulty usage of the equipment or from a fault in the equipment itself. The relative frequencies of these fires are subdivided by the age of the appliance involved, when known, in Table 2

---

\*Differences in the frequencies of fire given in this note and those in reference (1) are due to alterations made during the more detailed analysis necessary for the production of this note. The reports obtained from the fire brigades in the usual way were used to obtain supplementary information, thus causing a comparison to be made between these reports and the special survey reports.

Table 2

Fire incidence by the type of fault which occurred in relation to the age of the cooker or fish fryer involved

Age	Fault	
	in use	in the appliance
< 5	548	13*
≥ 5	472	22
Unknown	381	8
Total	1401	43

\*Two fires where the appliance was considered to have been at fault, in fact resulted from the faulty installation of the appliance.

Table 2 shows that for every fire occurring because of a fault in the appliance 32 were caused by the misuse of the appliance during the period of the survey.

Owing to the 389 fires where the age of the appliance concerned was not known, it is not possible to say whether the age of the appliance is a significant factor with regard to the fault occurrence. If, however, these 389 fires had the same age of appliance distribution in each fault category the age differences as between faults would be significant. Any significant difference would be caused by either, or both, of two factors: (a) that people are less likely to cause a fire by the misuse of an electric cooker the longer they have the appliance, and (b) that the incidence of faults in the appliance resulting in fire increases with the age of the appliance. It has been estimated<sup>(2)</sup> that in the households owning electric cookers during the period September - November 1958, 42.7 per cent of the cookers were less than 5 years old, which would imply that both factors (a) and (b) occur if those fires where the age of the appliance is unknown, could be ignored.

2. FIRES DUE TO FAULTS IN ELECTRIC COOKERS AND FISH FRYERS

In the twelve months under review only 43 fires resulted from a fault in an electric cooker or fish fryer. The faults which occurred are summarized in Table 3, and are described below.

Table 3

Fire incidence in relation to the fault in the appliance

Fault in appliance	Fire incidence
Faulty thermostat	16
Faulty switch	5
Earth fault	8
Defective insulation	6
Short circuit	2
Collapse of insulating material	2
Fault in installation	2
Miscellaneous	2
Total	43

A faulty thermostat caused the ignition of fat and/or other food on fifteen occasions and the ignition of a cupboard on one occasion; whilst a faulty switch caused fat and/or other food to ignite on five occasions.

In every instance where a fire occurred as the result of an earth fault a gas pipe had been punctured.

Collapse of the insulating material behind the cookers, considered to be part of a cooker for the purposes of easy classification, resulted in the ignition of structural materials by radiated heat from the cooker's oven on two occasions.

One fire occurred because a shelf inside an oven collapsed causing fat to spill.

Failure of the exhaust fan of a fish fryer caused another fire.

There were two cases of fire where the onus was on the person who installed the appliance involved, and are thus not strictly a fault in the appliance. In one case a hot-plate had been fitted into a linen cupboard and was being used as an airer, whilst in the other instance a cooker had been placed on bare floorboards which were ignited by conducted heat through the base of the cooker.

### 3. FIRES WHICH RESULTED FROM THE MISUSE OF ELECTRIC COOKERS AND FISH FRYING RANGES

In this section fires which originated from electric cooker appliances are frequently compared with fires originating from gas cooker appliances, since these are the most frequently used alternative methods of cooking. The information appertaining to gas cooker appliances has been obtained from Local Authority Fire Brigades in the usual way, and covers the same period as the Electrical Survey. Frequencies have been estimated from a 1 in 4 sample.

#### 3.1. Type of occupancy

Fire incidence by type of occupancy is shown in Table 4.

Table 4

Occupancy	Electric appliances	Gas appliances
Dwelling	1222	1424
Miscellaneous buildings	179	976
Total	1401	2400

Fish fryers accounted for a very high proportion of the fires which occurred in buildings other than dwellings, sixty fires being associated with electric fish fryers and six hundred and forty four being associated with gas fish fryers. Fat used in the fryers became overheated and ignited in every case. A comparison between fish fryers cannot, however, be made as there are no estimates of the numbers at risk available.

The heterogeneous nature of the appliances and circumstances involved in fires in buildings, other than dwellings, renders further analyses of these meaningless; fires in dwellings, however, have been considered in greater detail.

### 3.2. Fires in dwellings

It has been estimated that 3.661 million households in Great Britain own an electric cooker<sup>(2)</sup>, and 11.981 million own a gas cooker. The estimated regional distribution of electric cookers is shown in Table 5, together with the estimated total numbers of gas cookers (for which no regional breakdown is available).

Table 5

Region	Estimated number of households (millions)	Percentage owning		Number of cookers <sup>++</sup>	
		an electric cooker	a gas cooker	electric (million)	gas (million)
London & South East	5.692	17.1	/	.973	/
South West & Wales	2.020	33.9		.685	
Midlands	2.676	19.9		.533	
North West	2.112	22.9		.484	
North East & North	2.498	23.9		.596	
Scotland	1.648	22.0	.367		
<b>Total</b>	<b>16.640</b>	<b>22.0</b>	<b>72.0</b>	<b>3.661</b>	<b>11.981</b>

<sup>++</sup> Assuming one cooker per household.

The relationship of the regions shown in Table 5 with the Registrar General's standard regions are as follows:

Regions shown in Table 5	Registrar-General's Standard Regions
London & South East	Eastern, South & South Eastern
South West & Wales	South Western and Wales
Midlands	Midlands and North Midlands
North West	North Western
North East & North	Northern, East and West Ridings
Scotland	Scotland

The regional pattern of fires involving electric cookers is depicted in Tables 6 and 7, which show the material ignited first and the source of ignition respectively. A series of tests for association made apparent several significant features, which are marked on the tables by asterisks.

Table 6

Region	Material ignited first				Total
	Fat on hot-plate	Fat not <sup>+</sup> on hot-plate	Food	Miscellaneous	
London & South East	132	81*	74*	69*	356
South West & Wales	94	23	17	16	150
Midlands	65	24	20	16	125
North West	203*	44	24	17	288
North East & North	109	39	19	21	188
Scotland	73	8*	18	16	115
<b>Total</b>	<b>676</b>	<b>219</b>	<b>172</b>	<b>155</b>	<b>1222</b>

<sup>+</sup> includes those fires where the source of ignition was not stated

Table 7

Region	Source of ignition			Total
	Hot-plate	Oven	Miscellaneous <sup>+</sup>	
London & South East	221	108*	27	356
South West & Wales	111	27	12	150
Midlands	86	31	8	125
North West	227	46	15	288
North East & North	128	50	10	188
Scotland	103	7*	5	115
<b>Total</b>	<b>876</b>	<b>269</b>	<b>77</b>	<b>1222</b>

<sup>+</sup>includes those fires where the source of ignition was not stated.

The features of note are:

- (i) The housewife in the North West is particularly prone to causing a fire by frying on the hot-plate
- (ii) Fires caused by the ignition of materials, other than cooking ingredients, are associated with London and the South East.
- (iii) A fire in which an electric oven is the source of ignition is more likely to occur in London and the South East than elsewhere in Great Britain.
- (iv) In direct contrast to (iii), a fire emanating from an electric oven is less likely to occur in Scotland than elsewhere in Great Britain.

### 3.3. Fires in dwellings: occurrence leading to fire

The occurrences which led to the fires are listed in Table 8 according to the type of cooker involved.

Table 8

Occurrence leading to fire	Electric cooker	Gas <sup>+</sup> cooker
In use: ignition of material being heated or cooked	1037*	249
In use: miscellaneous	135	93
Accidentally turned on	36*	3
Miscellaneous	13	11
Not stated	1	-
<b>Total</b>	<b>1222</b>	<b>356</b>

<sup>+</sup>Actual frequencies recorded in the 1 in 4 sample.

Significant features are:

- (i) An electric cooker in use is more likely to ignite the material being heated than is a gas cooker.
- (ii) Fires caused by the accidental turning on of a cooker are associated with electric cookers rather than with gas cookers. This feature may, however, be more apparent than real, as when a gas cooker is accidentally turned on the source of ignition could be a match, for instance, or again the gas may not be ignited at all.

3.4. Fires in dwellings resulting from the ignition of material being heated or cooked

The fires, which occurred when fat, food and miscellaneous materials such as waxes, polishes and linen, were ignited while being cooked or heated, are listed in Table 9 in relation to the source of ignition.

Table 9

Source of ignition	Electric cooker	Gas <sup>+</sup> cooker
Hot-plate, ring	775	230
Oven	238	17
Grill	9	-
Not stated	35	2
Total	1037	249

<sup>+</sup>1 in 4 sample: actual frequencies

This table is very disturbing when related to the numbers at risk, that is 3.661 million electric cookers and 11.981 million gas cookers. In addition, the distribution patterns for the two types of cooker are significantly different, there being a strong positive association between fires emanating from the oven and electric cookers.

On the assumption that housewives owning electric cookers have identical behaviour patterns with those owning gas cookers, the conclusions at the 95 per cent confidence level, are:

- (i) an electric cooker hot-plate is between 2.4 and 3.2 times as likely to be the source of ignition of a fire as a gas cooker ring.
- (ii) an electric oven is between 7.7 and 18.4 times as likely to be the source of ignition of a fire as a gas oven.

Tables 10 and 11 describe the materials which were ignited first. In these tables the word "fat" has been used when no mention was made of food, but "fat and food" is described as "food". "Food" with hot-plates and rings is mainly composed of stew, whereas "food" with ovens refers to roast joints.

Table 10

Material ignited first	Electric hot-plate	Gas <sup>+</sup> ring
Fat	649	145
Food	89	74
Miscellaneous	17	11
Total	755	230

Table 11

Material ignited first	Electric oven	Gas <sup>+</sup> oven
Fat	160	13
Food	74	4
Miscellaneous	4	-
Total	238	17

<sup>+</sup>Frequencies in 1 in 4 sample.

The positive association shown in these tables between fat (for frying and for roasting) and electric cooker hot-plates and ovens accounts for the greater risk in cooking with an electric cooker rather than with a gas cooker, i.e. when fat is used for frying on a hot-plate rather than on a gas ring the chance of a fire occurring is between 3.3 and 4.1 times as great.

### 3.5. Fires in dwellings: miscellaneous occurrences leading to fire

These groups of fires, although showing equal incidence rates for electric and gas cookers\*, in fact, have quite different characteristics. Details are depicted in Table 12.

Table 12

Occurrence leading to fire	Electric cooker	Gas <sup>+</sup> cooker
Leakage of town gas .....	-	31
Electric flex placed too close .....	14	-
Fat spilt .....	19	4
Appliance turned off, but still sufficiently hot to ignite fat placed too close .....	2	-
Appliance in need of cleaning .....	14	2
Furniture and fittings too near appliance .....	35	12
Portable hot-plate being used for space-heating purposes ignited furniture and fittings .....	6	-
Person or person's clothing in contact with appliance .....	2	9
Person in contact with portable hot-plate being used for space heating purposes .....	2	-
Curtain blown onto appliance .....	12	18
Linen, clothing, towels either falling onto appliance or being aired too close .....	30	24
Paper blown onto appliance or placed too close .	4	3
Paraffin, waxes, polishes spilt or placed too close	8	1
Total	148	104

<sup>+</sup>Frequencies in 1 in 4 sample

\*See Section 3.3.



There are several significant features to note:

- (i) A danger characteristic to gas cookers is the ignition of leaking town gas.
- (ii) Likewise, a danger characteristic to electric cookers is the ignition of electric flex.
- (iii) Fires were caused by the usage of electric hot-plates for space-heating purposes.
- (iv) Furniture and fittings are more likely to be ignited when the cooking appliance is electric than when it is gas, under the assumption of similar behaviour patterns for both groups of households.
- (v) Fat and electric cooker appliances again appear as a dangerous combination. The importance of cleaning electric cooker appliances, particularly ovens, is emphasized.
- (vi) The ignition of clothing on the person is more likely to occur with gas cooker appliances than with electric cooker appliances.

#### 4. ELECTRIC KETTLES AND TOASTERS

Fires caused by electric kettles, during the period September 1957 to August 1958, are listed in Table 13 by the material which was ignited first.

Table 13

Fire incidence of electric kettles  
in relation to the material ignited first

Material ignited first	Fire incidence
Furniture or fittings	9
Stand or board	3
Floor, linoleum, or carpet	9
Curtain	3
Plug and socket	6
Electrical insulation	4
Paper	1
Rubber tube of liquid petroleum gas apparatus	1
Town gas	1
Not stated	2
<b>Total</b>	<b>39</b>

The kettle was accidentally turned on in only two of the thirty-nine cases of fire, whereas in thirty-six of the cases the kettle was left on, boiled dry and overheated. On the occasion when town gas was ignited the kettle was apparently in normal use.

Electric toasters when left on, overheat if they are not fitted with a time control, or this mechanism fails. During the period of the survey six fires were caused in this way. The materials ignited by the toasters are shown in Table 14.

Table 14

Fire incidence of electric toasters  
in relation to the material first ignited

Material first ignited	Fire incidence
Floor, linoleum, or carpet	3
Curtain	2
Bread	1
Total	6

### 5. CASUALTIES

The number of people injured by burning are shown in Table 15 in relation to the appliance involved.

Table 15

Casualty	Gas cooker <sup>†</sup>	Electric cooker	Kettle	Toaster
Fatal	3	-	-	-
Non-fatal	28	56	1	1

<sup>†</sup>Frequencies in 1 in 4 sample.

Those casualties where an electric cooker was involved, occurred in fifty-one incidents of fire, forty-three of which occurred in dwellings.

Although the ignition of clothing on the person is more likely to occur with a gas cooker (and was the cause of the three fatalities above) than with an electric cooker, it is apparent that the chances of a person's being burned are just as high with an electric cooker as with a gas cooker. The incidence rate for electric cookers is higher than that for gas cookers, but not significantly higher.

The causes leading up to the fire, and the casualty, or casualties, are summarised in Table 16 for the fires involving electric cookers only.

An interesting feature of the table is the high number of incidents in dwellings where fat was the material ignited first.

Table 16

Hazard	Source of ignition	Misuse	Material ignited first	Occurrence	Frequency
Dwelling	Oven	Accidentally turned on	Fat	Boiled over	1
"	Portable hot-plate	Used for space-heating	Clothing on person	Person in contact	1
"	Hot-plate	Left on (or not stated)	Paraffin	Placed too close	1
"	"	"	Curtain	Blown on to	1
"	"	"	Clothing on person	Person in contact	1
"	"	"	Wax or polish	Boiled over	1
"	Oven	"	Fat in which a joint of meat was roasting	Overheated	1
"	"	"	"	"	2
"	Hot-plate	"	"	"	34
Miscellaneous buildings	Portable hot-plate	Placed too close to	Paper	-	1
"	Hot-plate	Not stated	Furniture	Too close	1
"	"	"	Flammable liquid or gas	Container broke	1
"	"	"	Clothing on person	Person in contact	1
"	"	"	Wax or polish	Boiled over	1
"	"	"	Fat	"	3

#### CONCLUSIONS

Between September 1957 and October 1958, approximately thirty-two times as many fires were caused by the misuse of an electric cooker or fish fryer as resulted from faults in these appliances.

Fires are caused by electric kettles and toasters when these appliances are left on and overheat, either because they are not fitted with a time control or because this mechanism fails to act.

Fires originating from electric and gas cookers and fish fryers in buildings, other than dwellings could not be analysed statistically owing to the heterogeneous nature of the appliances and circumstances involved, and the lack of estimates of the numbers at risk.

A regional pattern of fires involving electric cookers in dwellings appears. Fires caused by frying on an electric hot-plate predominate in the North West of England; whereas a characteristic of London and the South East of England is the ignition of materials of a miscellaneous nature such as furniture and fittings, curtains, towels and linen. There is also a positive association with the occurrence of a fire in an electric oven and London and the South East of England, and a negative association between fires of this type and Scotland. There is no evidence to suggest that this regional pattern does not reflect living habits in the respective areas.

Electric cookers are found to present a greater fire hazard than gas cookers, because fat is ignited more easily by an electric cooker appliance than by a gas cooker appliance. An electric oven is particularly conspicuous in this respect, being roughly between seven and eighteen times as likely to be the source of ignition of a fire as a gas oven, in comparison with an electric hot-plate which has a chance (of being the source of ignition of a fire) between three to four times as great as a gas ring.

Several other significant features have been noted, one being the greater chance of the ignition of clothing on the person with gas cooker appliances than with electric cooker appliances. The number of people suffering injury from burns in dwellings nevertheless was just as high with electric cookers as with gas cookers, when related to the number of cookers at risk.

#### References

1. LUSTIG, R. E. Fire Hazards of Electrical Apparatus. II. Some preliminary analyses. Joint Fire Research Organization F.R.Note No. 454, 1960.
2. Woman and the National Market. Domestic Electrical Appliances. Odhams Press Ltd. May, 1959.