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THE CAUSES OF FIRES IN DWELLINGS

by

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SUMMARY

A study has been made of all fires in dwellings attended by Local Authority Fire Brigades in one year (1956) and this note is concerned with the causes of these fires. About half are connected with heating appliances of which the open fire occurs most frequently. Cooking appliances, miscellaneous electrical equipment and installations, and smoking materials are all frequently encountered as sources of ignition. About half the fires appear to result from some action or omission (through ignorance or carelessness) on the part of the occupants.

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Introduction.

Approximately half of the fires in buildings attended by Fire Brigades occur in dwellings and it is obviously desirable to obtain as comprehensive a picture as possible of the causes of such a numerically important group. With this end in view a special study has been made of all reports of fires in dwellings received from Fire Brigades in Great Britain during a period of one year, 1956. For the purposes of this study only fires in private residential property have been considered and reports of fires in boarding houses, hostels, hotels, schools and other institutional and non-private residences have been excluded. This note deals with the causes of the fires and with the materials first ignited in them.

Since the design of dwellings and, to some extent, materials and methods of construction underwent changes between 1939 and 1945, dwellings built during the post-war years have been regarded as forming a separate group. Most of the reports include information on the date of construction, but where this has not been given or has been entered as "unknown" it has been assumed to be earlier than 1945 in the supposition that dates of construction of post-war buildings are better known that those of earlier ones.

A resumé of the results of the survey is given in Table 1 from which it can be seen that 50.4 per cent of the fires in the pre-war group of dwellings were caused by heating appliances, 11.2 per cent by cooking appliances and 12.5 per cent by other domestic apparatus and electrical installations. The pattern of incidence in the post-war dwellings differed slightly from this in that a smaller proportion of the fires 44.5 per cent were caused by heating apparatus and larger proportions, 14.7 per cent and 23.2 per cent respectively by cooking appliances and by other apparatus and electrical installations.

Table 1.

Cause of fire and material first ignited

Cause	Material first ignited								Total	
	Structural and/or ftgs		electrical insulation		Contents		Unknown			
	pre war	post war	pre war	post war	pre war	post war	pre war	post war	pre war	post war
Heating appliances	4858	278	6	1	5963	829	13	2	10840	1110
Cooking appliances	70	19	1	0	2326	347	2	0	2399	366
Other appliances and electrical installations	163	12	622	108	1904	206	3	0	2692	326
Miscellaneous	1340	118	29	4	3302	449	124	7	4795	578
Unknown	46	4	0	1	154	30	575	79	775	114
TOTAL	6477	431	658	114	13649	1861	717	88	21501	2494

Fires caused by heating appliance.

The heating appliances causing fires and the materials first ignited are shown in Table 2. The most prominent item here is "fire in grate" which caused about 17 per cent of the fires in both pre-war and post-war houses. In a large proportion of these incidents the material ignited first was shown as "contents", and these were generally combustible materials placed near to the fire and ignited by radiant heat, sparks or live coals. There were 1146 incidents in which furniture or furnishings were ignited and 670 started in linen airing in front of the fire. It is clear from this group of reports that not only the provision, but the correct use of adequate guards is of importance. Apart from education of the public, there is little that can be done to prevent these fires while the open grate remains popular, although grates with integral guards might achieve something in this direction. In any event the situation is unlikely to change rapidly.

Defective hearths which resulted in the ignition of timber beneath them caused 8.5 per cent of the fires in pre-war houses, and this is a known fault likely to continue to cause fires in older dwellings. It is surprising, however, to find 3 per cent of the fires in post-war dwellings resulting from faulty hearths since the construction of hearths is fully covered in bye-laws; it can only be assumed that inspection to ensure compliance with the provisions of the bye-laws is not completely effective.

Table 2.

Fires caused by domestic heating appliances and material first ignited - England, Wales and Scotland, 1956

Cause of fire	Material first ignited						Total	
	Structural and/or ftgs		Contents		Other and unknown			
	pre war	post war	pre war	post war	pre war	post war	pre war	post war
Fire in grate	612	22	2924	399	5	0	3541	421
Fire in grate,defective hearth	1809	73	25	3	0	0	1834	76
Slow combustion stove,boiler	69	7	179	25	0	0	248	32
Electric fire, heater	50	3	727	92	2	0	779	95
Electric immersion heater	17	2	43	11	2	0	62	13
Gas fire heater	10	0	128	5	0	0	138	5
Gas water heater	15	1	53	4	0	0	68	5
Oilburning space heater	104	8	844	113	6	0	954	121
Flue - radiated heat	229	45	37	13	0	2	266	60
Flue - sparks from	480	36	125	8	0	0	605	44
Chimney fire	891	52	438	80	2	1	1331	133
Ashes - soot	327	19	412	68	2	0	741	87
Sparksfrom chimney (outside)	243	10	21	8	0	0	264	18
Other heating appliance	2	0	7	0	0	0	9	0
TOTAL	4858	278	5963	829	19	3	10840	1110

Fires caused by cooking appliances

The majority of households cook by gas or electricity and, as might be expected, most of the cooking apparatus fires were caused by appliances using these fuels although there were some associated with liquid petroleum gas, some with solid fuel and some with oil. In pre-war dwellings the number of fires caused by gas cookers exceeded the number caused by electric cookers, but the relationship was reversed in post-war dwellings presumably because of the higher proportion of electric cookers at risk in post-war as compared with pre-war dwellings. A Coal Utilisation Council Survey(1) in 1952 showed that 14 per cent of pre-war and 24 per cent post-war houses had electric cookers.

Information on the types of apparatus involved and the materials ignited in cooking appliance fires is given in Table 3 from which it will be seen that

Table 3

Fires caused by domestic cooking appliances and material first ignited - England, Wales and Scotland, 1956

Apparatus causing fire	Material first ignited						Total	
	Structural and/or fittings		contents		other and unknown			
	pre war	post war	pre war	post war	pre war	post war	pre war	post war
Coal gas cooker, oven	16	3	1009	118	1	0	1026	121
Coal gas ring	6	1	183	4	0	0	189	5
Electric cooker, oven	9	7	769	195	0	0	778	202
Electric ring	5	0	30	0	0	0	35	0
Electric kettle	8	1	32	1	1	0	41	2
Kitchen range	21	7	113	6	1	0	135	13
Liquid petroleum gas cooker	2	0	10	1	0	0	12	1
Oil fuelled cooker, oven	2	0	28	4	0	0	30	4
Other and undefined	1	0	152	18	0	0	153	18
TOTAL	70	19	2326	347	3	0	2399	366

although cooking appliances some times cause the ignition of structural materials or fittings in a dwelling, this happens comparatively rarely (89 out of 2765 incidents) and, in most of the fires, contents of the building (food, furniture, clothing, etc) are ignited first. A more detailed list of materials ignited first in fires in dwellings, given in Table 8 in a later section of this report, shows that cooking apparatus causes the ignition of a wide range of materials of which food is the most usual, but clothing and furniture are not infrequently ignited.

Some indication of the relative hazard of gas and electric cookers is obtained from Table 4. In compiling this table it was necessary to take into account the numbers of cookers at risk; it is known that in 1956 the number of gas cookers was somewhere between three and four times the number of electric cookers and for the sake of computation this has been taken as $3\frac{1}{2}$ times. On this basis it is seen that the incidence of fires associated

Table 4

Relative fire hazard of gas and electric cookers in dwellings - England, Wales and Scotland, 1956

Type of cooker	No. of fires				
	total	Food ignited first		Clothing on person ignited first	
		No.	%	No.	%
Gas	1147	723	63	37	3.2
Electric	980	843	86	2	0.2
Electric/gas relative hazard(scaled on basis of no.at risk	About 3	About 4	-	About 0.2	-

with electric cookers, relative to the numbers in use, is some three times greater than that for gas cookers. This may be due in part to the greater likelihood of igniting food on electric cookers - 86 per cent of the total fires originating in electric cookers involved food as the material first ignited, the corresponding figure for gas cookers being 63 per cent. It appears from these figures that the use of an electric cooker is roughly 4 times as likely to result in fire by the ignition of food as the use of a gas cooker. On the other hand, for the ignition of clothing while being worn the electric cooker constitutes a smaller hazard than the gas cooker (relative hazard about 0.2) and is thus of less direct danger to the user.

Fires caused by miscellaneous domestic equipment and installations

The number of fires caused by various domestic appliances and electrical and gas installations are shown in Table 5. The bulk of modern domestic equipment is powered by electricity and it is therefore not surprising that 1370 of the 3018 fires were started by electrical apparatus and 1281 by electrical installations.

Of 572 fires starting in wireless and television sets 422 were confined to the sets in which they originated.

There were 1152 electrical installation fires in pre-war dwellings and 457 of these involved coalgas. It is known that these fires can occur when electrical and coal gas installations are laid together and are at different electric potentials; electrical earth faults can then cause arcing to the gas pipe and subsequent ignition of gas, particularly in the case of "composition" gas pipes.

Miscellaneous causes of fire

Several causes of fire, not related to apparatus of a specially domestic character, were encountered in the investigation and these are recorded in Table 6.

Table 5

Fires caused by domestic appliances and installations other than cooking and heating - England, Wales and Scotland, 1956

Cause of fire	Material first ignited								Total	
	Structure and/or fittings		Electrical insulation		Contents		Unknown			
	pre war	post war	pre war	post war	pre war	post war	pre war	post war	pre war	post war
Electric lamp	12	1	1	-	53	6	-	-	66	7
Electric lead to appliance	13	2	9	-	160	13	-	-	182	15
Electric iron	36	3	-	-	147	25	1	-	184	28
Electric wireless, T.V	1	1	-	-	491	79	-	-	492	80
Electric other appliance	8	1	1	-	275	31	-	-	284	32
Gas heated washboiler	1	-	-	-	16	5	-	-	17	5
Gas lamp	3	-	-	-	10	-	-	-	13	-
Gas other appliance	13	1	-	-	71	13	1	-	85	14
Oil lamp	17	1	-	-	45	1	1	-	63	2
Oil other appliance	-	-	-	-	9	1	-	-	9	1
Refrigerator (all types)	-	-	1	-	117	10	-	-	118	10
Other movable appliance	-	-	-	-	5	-	-	-	5	-
Electrical installation	56	2	608	108	488	19	-	-	1152	129
Other installation	3	-	2	-	17	3	-	-	22	3
TOTAL	163	12	622	108	1904	206	3	-	2692	326

Table 6

Fires in dwellings due to miscellaneous causes - England, Wales and Scotland, 1956

Cause of fire	Material first ignited						Total	
	Structural and/or fittings		Contents		Other and unknown			
	pre war	post war	pre war	post war	pre war	post war	pre war	post war
Blowlamp	596	24	115	4	1	-	712	28
Lightning	23	24	29	4	27*	4*	79	32
Malicious ignition	4	-	69	9	22	2	95	11
Matches	4	3	288	28	-	-	292	31
Children with matches	6	1	419	101	1	-	426	102
Naked light	23	2	319	51	2	1	344	54
Tapers, candles	44	4	238	21	1	-	283	25
Smoking materials	36	2	1518	185	1	-	1555	187
Spread from other dwelling	285	39	10	-	70	3	365	42
Spread from other hazard	265	14	16	1	26	1	307	16
Other causes	54	5	281	45	2	-	337	50
Unknown	46	4	154	30	575	80	775	114
TOTAL	1386	122	3456	479	728	91	5570	692

* Electrical insulation ignited first in these fires.

The careless disposal of smoking materials and matches constitutes the largest single cause of fires in these miscellaneous categories. Smoking materials were reported as the cause in 1742 of the 6262 fires due to miscellaneous causes and were thus responsible for about 7.3 per cent of all fires in dwellings in 1956. In 826 of the smoking material fires furniture and furnishings were the materials ignited first and there were 379 incidents in which bedding was ignited. There were 38 fatal fire incidents attributed to smoking materials in which 40 persons lost their lives.

Differences in cause pattern in pre-war and post-war dwellings

Differences between the causes of fire in pre-war and post-war dwellings are apparent from a study of the tables in preceding sections of this report. For convenience the main items are summarised in Table 7 and from this it may be seen that the ratio of the ffequencies of fires

Table 7

Comparison of causes in pre-war and post-war dwellings - England, Wales and Scotland 1956

Dwelling	Cause				
	Heating Appliances	Cooking Appliances	Other domestic appliances	Miscellaneous	All causes
Pre-war	10840	2399	2692	5570	21501
Post-war	1110	366	326	692	2494
Ratio $\frac{\text{Pre-war}}{\text{Post-war}}$	9.8	6.5	8.3	8.1	8.6

from all causes in pre-war and post-war houses is 8.6 : 1. Neither the frequencies of fires due to miscellaneous causes nor that of fires due to general domestic appliances departs seriously from this ratio. Heating appliances, however, are seen to be more dangerous in pre-war dwellings and this is mainly because of the high frequency of fires caused by defective hearths. Cooking appliances appear to be more dangerous in post-war dwellings as might be expected from the rate of incidence in electric cookers which are more frequently installed in newer dwellings than in older ones.

Fires in which structural materials were ignited first

Structural materials were ignited first in 30.1 per cent of the fires in pre-war dwellings and in 17.3 per cent of those in post-war dwellings. The materials ignited and a broad classification of the igniting sources are shown in Table 7.

In pre-war dwellings fires in which there was ignition of timber under hearths, wooden fire place surrounds and timber set in chimneys constituted about 43.6 per cent of the total fires. In post-war dwellings this group constituted only 20.4 per cent of the fires. The difference may be partly attributable to the difference in age of the buildings, but is also likely to be at least partly due to different methods of construction. Nearly three quarters of the fires in which structural materials were ignited were caused by heating appliances, a fact which emphasises the importance of adequate fire precautions in the installation and construction of such appliances.

Table 8

Fires in dwellings in which structural materials were ignited first - England, Wales and Scotland, 1956

Material ignited first	Cause of fire									
	Heating appliance		Cooking or other appliance		Miscellaneous causes		Unknown		Total	
	pre war	post war	pre war	post war	pre war	post war	pre war	post war	pre war	post war
Roof	831	26	21	1	365	36	27	0	1244	63
Roofing felt or lining	16	18	5	0	26	26	0	2	47	46
Ceiling	131	15	10	1	127	13	3	0	271	29
Partition, wall, wall lining	111	29	12	8	63	4	1	0	187	41
Floorboard, flooring	501	37	65	8	101	5	6	0	673	50
Timber under-hearth	1850	72	2	0	2	0	0	0	1854	72
Wooden fire-place surround	332	4	16	0	0	1	0	0	348	5
Timber set in chimney	614	11	9	0	0	0	0	0	623	11
Built-in cupboard	39	11	9	1	2	3	0	0	50	15
Other wooden fittings	321	26	46	10	521	15	6	0	894	51
Pipe and tank lagging	71	15	34	1	124	11	3	2	232	29
Flue casing	9	5	1	0	1	0	0	0	11	5
Other structural materials	32	9	3	1	8	4	0	0	43	14
TOTAL	4858	278	233	31	1340	118	46	4	6477	431

Fires in which contents of dwellings were ignited first

The most frequently ignited contents of dwellings are furniture, furnishings and carpets, and airing clothing and linen, but as may be seen from Table 8, there are other materials which are ignited with an unexpectedly high frequency. Bedding and flammable liquids are examples of this, and reference has already been made to the ignition of food in cookers.

The numbers of incidents in which clothing was ignited while being worn and of those causing "burns to the person only" should not be regarded as an accurate indication of the numbers of casualties due to these causes since the table refers only to those incidents attended by local authority Fire Brigades. Brigades are not called to all incidents of this type and the proportion not attended is not known.

Table 9

Fires in dwellings in which contents were ignited first
England, Wales and Scotland, 1956

Material ignited first	Causes of fire									
	Heating appliance		Cooking appliance		Other domestic appliance		Miscellaneous and unknown		Total	
	pre war	post war	pre war	post war	pre war	post war	pre war	post war	pre war	post war
Furniture, furnishings and carpets	1754	240	146	14	177	21	1236	194	3313	469
Floor covering (other than carpet)	126	13	6	0	11	1	16	1	159	15
Bedding (on bed)	207	24	9	0	162	20	508	69	886	113
Airing clothes, linen, bedding	888	128	116	200	20	2	19	3	1043	153
Clothing etc in linen cupboard	44	12	0	0	15	3	24	16	83	31
Clothing on person	433	68	51	9	5	1	69	20	558	98
Burns to person only	5	0	0	0	1	0	1	0	7	0
Food	23	4	547	266	4	0	4	0	1578	270
Flammable liquids	708	91	82	5	32	4	102	13	924	113
Faulty domestic appliances	26	3	14	3	801	108	6	0	847	114
Soot in or behind fireplace	406	21	6	0	0	0	0	0	412	21
Soot in chimney	253	59	1	0	0	0	3	0	257	59
Coal gas	85	10	126	11	503	20	135	9	849	50
Rubbish	247	59	99	0	12	0	478	47	746	106
Other contents	758	97	213	19	161	26	854	107	1987	249
Unknown	13	2	2	0	3	0	699	86	717	88
TOTAL	5976	831	2328	347	1907	206	4155	565	14366	1949

Responsibility for fire

If any attempt to reduce the incidence of fires in dwellings is to be effective it is necessary to know something of the basic causes of the fires, that is what actions or defects gave rise to ignition. An attempt has been made in the present study to decide where the primary fault lay in each of the incidents examined. Where the fire was due to a mechanical failure, or a fault in construction or workmanship, or to spread from another building or hazard, there was generally no difficulty in allocating responsibility for the outbreak. The decision was more difficult in those incidents involving some action of the occupants of the dwelling. The results of this analysis are summarised in Table 10.

Fires attributed to "action of occupant" were not necessarily the result of deliberate or gross misuse of equipment, but were often due to ignorance or thoughtlessness as in the case of "fat boiling over on cooker", "airing linen too near fires", etc. Nevertheless it is fairly clear that more than half the fires in dwellings could have been prevented by a more fire conscious attribute on the part of the occupants.

Table 10

Responsibility for fires in dwellings, England, Wales and Scotland, 1956

Act or fault causing fire	Fires	
	No.	%
Action of occupant	12109	50.5
Failure of moveable equipment	1749	7.3
Failure of structural component or fixed equipment	6253	26.1
Spread from other hazard	749	3.0
Accident or chance occurrence	2258	9.4
Unknown	877	3.7
TOTAL	23995	100

The fires attributed to faults in structural components and fixed equipment (chimneys, fireplaces, etc.) could not have been so easily avoided since some of the faults would have remained hidden until the outbreak of fire drew attention to them.

The phrase "accident or chance occurrence" has been used to describe causes such as "lightning" and "wind blowing flammable material onto flame". Some of these may have been avoidable, but others were unpredictable and outside human control.

Extent of damage

To some extent the growth of a fire once started is likely to be independent of the source of ignition. There are, however, some causes related to particular types of damage, for example damage to the structure of a dwelling is more frequently associated with heating appliance fires than with fires of other causes. The extent of damage by fire and heat in fires due to different causes is shown in Table 11.

Over 90 per cent of the fires in dwellings, both post-war and pre-war, were confined to the rooms in which they originated. Fires attributed to heating appliances tended to cause structural damage more frequently than those attributed to other causes (presumably because the appliances themselves usually form part of the structure of dwellings), and this was more pronounced in pre-war than in post-war dwellings though whether the difference is due to age or to methods of construction is not known.

The highest proportion of fires confined to the contents of the room of origin started in cooking appliances. Many of these were, in fact, confined to the material, usually food, which was ignited first.

The maximum spread of fire was in the incidents of unknown cause; this was probably due to the destruction of evidence of the cause where damage was most extensive.

Table 11

Extent of damage by fire and heat in fires in dwellings. England, Wales and Scotland, 1956

Extent of damage by fire and heat		Heating appliances		Cooking appliances		Other domestic appliances		Miscellaneous causes		Unknown causes		Total	
		Prewar	Postwar	Prewar	Postwar	Prewar	Postwar	Prewar	Postwar	Prewar	Postwar	Prewar	Postwar
Confined to contents and fittings in room of origin	No.	4307	557	1843	274	1554	225	2606	317	269	53	10579	1426
	%	39.7	50.2	76.8	74.9	57.7	69.0	54.4	54.8	34.7	46.5	49.2	57.2
Confined to room of origin (some structural damage)	No.	5798	477	504	81	953	85	1799	228	309	36	9363	907
	%	53.5	43.0	21.0	22.1	35.4	26.1	37.5	39.4	39.9	31.6	43.5	36.4
Confined to room of origin and neighbouring rooms	No.	430	33	40	5	126	12	193	11	84	10	873	71
	%	4.0	3.0	1.7	1.4	4.7	3.7	4.0	1.9	10.8	8.8	4.1	2.8
Confined to dwelling of origin	No.	107	26	4	5	30	3	90	10	63	9	294	53
	%	1.0	2.3	0.2	1.4	1.1	0.9	1.9	1.7	8.1	7.9	1.4	2.1
Spread beyond dwelling of origin	No.	198	17	8	1	29	1	107	12	50	6	392	37
	%	1.8	1.5	0.3	0.3	1.1	0.3	2.2	2.1	6.5	5.3	1.8	1.5
TOTAL	No.	10840	1110	2399	366	2692	326	4795	578	775	114	21501	2494

Conclusions

Approximately half of the fires in dwellings are attributable to heating appliances and the open fire is the chief culprit. While defective hearths and chimney fires are responsible for many of these fires, most are due to the actions of occupiers or to failure to use efficient fire guards.

About 11 per cent of the fires in dwellings start in cooking appliances, but a high proportion of these fires do not spread beyond the material ignited first. There is a greater probability of starting a fire with an electric cooker than with a gas cooker, but the risk of igniting clothing while being worn is greater with the gas cooker than with the electric one.

In 1956 about 11 per cent of the fires in dwellings started in electrical installations or electrical apparatus other than that used for heating and cooking and this proportion is likely to increase as more electrical domestic equipment comes into use.

Smoking materials cause a serious proportion of fires in dwellings (7.3 per cent in 1956), and smoking in bed is an obvious hazard to life.

Heating appliances appear to be more likely to cause fires in pre-war dwellings than in post-war ones and the reverse appears to be the case for cookers.

Structural materials appear to become ignited more frequently in pre-war than in post-war houses, but it is not known at present whether this is an age effect or whether new forms of construction account for the difference.

About half of the fires in dwellings appear to be due to ignorance or carelessness on the part of the occupants.

Most fires in dwellings are confined to the rooms in which they originate.

Reference.

(1) A survey into the domestic use of solid fuel - solid fuel appliances in Great Britain, Coal Utilization Council, 1952.