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FIRES ATTRIBUTED TO FRICTION SPARKS

by

K. N. Palmer

Summary

Details have been collected of all fires attributed to friction sparks which were attended by public Fire Brigades within the period 1st October, 1955, to 30th September, 1956; the monthly rate of incidence appeared to vary through the year. The materials first ignited by the friction sparks were usually solids, particularly textiles, and the sources of the sparks were usually some form of powered machinery. Very few fires were attributed to non-powered hand tools.

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Fire Research Station,
Boreham Wood,
Herts.

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Introduction

Each year there are several hundred fires attended by public Fire Brigades in the United Kingdom which are attributed to frictional sparking or heating, according to the analyses of Fire Brigade reports summarised in the Annual Reports of the Joint Fire Research Organization (1). In the analyses no distinction is drawn between fires attributed to small hot transient sources (sparks) and those due to larger sources, such as overheated bearings, which may be at considerably lower temperatures. It has long been realised that friction sparks might be an industrial fire hazard and that the ordinary manipulation of hand tools, unless of a non-sparking type, might lead to the generation of dangerous sparks. In a recent review of available information (2) it was concluded that many combustible materials could be ignited in air by friction sparks if the energy of the impact producing the sparks were high, but that with the low energy impacts usual with hand tools a definite opinion could not be given.

In order to obtain further information about the importance of the problem of fires due to friction sparks a special collection has been made of details of all fires in the United Kingdom attended by Fire Brigades in the period 1st October, 1955 to 30th September, 1956 in which the cause of the fire was attributed to friction sparks. Fires due to other types of spark, or to glowing embers, or to frictional heating without sparks, have not been considered. The results of the collection form the basis of this report.

Method of collection and reliability of information

After every fire in the United Kingdom attended by a public Fire Brigade a report on the fire is completed on a standard form (K 433) by the Fire Brigade. Each of these reports is sent to the Joint Fire Research Organization for statistical analysis, and since September, 1955 all reports dealing with fires attributed to friction sparks have been set aside during the sorting. The information given on the reports includes the supposed cause of the fire and the materials first involved, the date of the fire, the address and occupancy where the fire occurred, as well as the name of the Fire Brigade in attendance. By means of these reports it has thus been possible to collect details of all fires attributed to friction sparks which occurred within one calendar year in the United Kingdom and were attended by a public Brigade.

As all incidents in the year are taken into account the errors inherent in sampling do not arise. The major uncertainty is therefore that of the accuracy of diagnosis of the cause of the fire; this can obviously vary considerably. For example there would be no room for doubt in a case where a friction spark was seen to start the fire, but in other cases direct evidence may be lacking and the supposed cause was that considered to be the most probable of several alternatives. No definite provision is made in the reports for estimations of the confidence to be put in the diagnosis, and so for the present purpose all reports were assumed to be of equal value. As a result of this assumption the total number of fires attended by Fire Brigades and attributed to friction sparks may differ from the real number of fires actually due to this cause; but the difference cannot be accurately assessed. Uncertainty about the total number of fires should not however affect relative numbers of fires, such as the ratio of numbers of fires in solid to numbers in gaseous combustibles.

Analysis of information

1. The total number of fires and the monthly variation in incidence

In the period 1st October, 1955 to 30th September, 1956 a total of 335 fires was attributed to friction sparks; this total is about 36 per cent of the average estimated annual total of fires due to friction sparks and mechanical heating during the period 1950-54(1). The monthly variation in the rate of incidence of friction spark fires between 1st October, 1955 and 30th September, 1956 is shown in Fig. 1, no allowance being made for variations in the number of days per month. It can be shown that the deviations from the mean number of fires per month are statistically significant at the 0.001 level, and from the graph it may be seen that the number of fires reached a maximum in the spring. As will be shown below, about 60 per cent of all the fires originate in textile and allied materials and so the monthly incidence of textile fires due to friction sparks is also shown in Fig. 1. There is again a strong seasonal trend, with the probability of the observed deviations from the mean value arising by chance lying between 0.01 and 0.001. In contrast there is no evidence of significant seasonal trends in the fires in all materials other than textiles.

The reason for the seasonal variation in the number of friction spark fires in textiles has not been elucidated, but the increase in numbers in the early part of 1956 was not the result of greatly increased activity in the industry, since the rates of consumption of raw cotton and wool remained fairly steady during the period. Values for these rates, obtained from official sources (3), are included in Fig. 1. The rates of production of yarn, which are not shown in Fig. 1, likewise showed no trend comparable with that of the incidence of fires during the twelve months. It is possible that the seasonal variation in numbers of fires was due to climatic conditions, although Millar and Fry in a report (4) on all fires in textile finishing trades during the five years 1946-50, showed no significant trends in the monthly rates of incidence. Further collection of information about fires due to friction sparks is necessary before a definite explanation of the seasonal trend can be established.

2. Materials first ignited by friction sparks

The materials first involved in friction spark fires are listed in Tables 1 and 2, together with the numbers of incidents with each material. The classifications of "solid", "liquid", and "gas" refer to the state of the material at N.T.P.

Table 1

Fires in solid materials

Material	Number of fires
Cotton, including dust and fly	129
Wool, including mungo and shoddy	47
Hemp, jute	13
Other fibres	13
Wood dust, including flour and chips	30
Leather, rubber dusts	22
Chemicals, including dyestuffs and fertilisers	9
Metal dusts, including swarf	9
Paint deposit, including paint base and varnish	6
Oilseed, oilcake	3
Plastics dust	2
Polishing dust	2
Other dusts	9
Unspecified dusts	16
Total	310

Table 2

Fires in liquid or gaseous materials

Material	Number of fires
Liquid:	
Paint, including cellulose lacquer	7
White spirit	6
Petrol	3
Others	4
Unspecified	2
Gas:	
Acetylene	2
Other	1
Total	25

A striking feature of the information is the preponderance of fires originating in solid materials; these fires outnumber the remainder by more than 12 to 1. This disparity may result partly from solid materials being exposed more frequently to friction sparks than other materials, but it is also likely that combustible solids, especially those with a high specific surface, are more prone to ignition by friction sparks than are liquids and gases. Thus in experiments on the fire hazard of friction sparks it would be advisable to place emphasis on the ignition of solids; in the past there has been a tendency in experimental work to use liquid or gaseous combustibles (2) and the ignition of solids by friction sparks has not received the proportion of systematic attention that it deserves on the basis of the figures given above.

About 65 per cent of fires involving solids originate in textile and allied fibrous materials and it is the apparent seasonal trend in these textile fires which is largely responsible for a similar seasonal effect in the total number of fires attributed to friction sparks, discussed above. The majority of the textile fires occurred in cotton and account for over 40 per cent of all the fires in solids, and so it may be said that the cotton industry is the one most prone to fires caused by friction sparks; the stage at which friction spark fires are most likely to occur in the manufacture of cotton goods is discussed below. The remaining fires in which solids were first ignited occurred in a wide range of industries, prominent among which were the timber and the leather and rubber trades.

Apart from their comparative fewness in number the fires involving liquids or gases showed no marked features (Table 2). The six fires initiated in white spirit are unexpected, since the flash point of white spirit is at least 78°F (5) and is thus above usual room temperature; however four of the fires occurred in dry cleaning tumblers, where the spirit would be warm. The temperatures of the white spirit in the other two instances were not given.

3. Sources of sparks

Although a total of 335 fires were reported during the period only seven were ascribed to low energy impacts such as the manipulation of non-powered hand tools, the use of hob-nailed boots, or the dropping or moving of heavy objects. A list of the seven incidents, together with the materials involved, is given in Table 3. The materials ignited by low energy impacts are not a representative selection of the materials listed in Tables 1 and 2; for instance there are no cases involving textile dusts, and in the majority of cases strong oxidising or reducing agents were present.

The remaining 328 incidents all occurred in the presence of power driven machinery and owing to the preponderance of fires involving textiles a total of 164 fires were attributed to machinery designed specifically for the textile industry. Fires in textiles attributed to

Table 3

Friction spark fires not attributed to powered machinery

Source of spark	Material first ignited
Steel spanner dropped	Methylated spirit
Iron scraper on concrete floor	Paint thinners
Metal boot studs on floor	Distress signal flare, powder from
Steel drums moved	Wooden box contaminated with sodium chlorate
Metal scoop	Nitrocotton
Iron scoop	Mixture of aluminium powder, titanium dioxide, and potassium perchlorate
Metal dunnage dropped	Flowers of sulphur
Total	7

friction sparks occur mainly during the processing of the raw material prior to spinning (Table 4). For example the breaking, opening, mixing, scutching, and carding machines used in the cotton industry convert the cotton into a form suitable for spinning and also eliminate dirt and impurities. The teasing, willeying, carbonising, scribbling, and carding machines perform a similar function in the woollen industry. An important part of the processes in both industries consists of beating and tearing the fibres in order to open them out and so any dirt or impurity present that is liable to cause friction sparks may be submitted to heavy impacts. The possibility of fires developing

Table 4

Friction spark fires attributed to textile manufacturing machinery

Machinery	Number of fires
Breaking machine	54
Opening "	12
Mixing "	4
Scutching "	22
Teasing "	8
Willeying "	5
Carbonising "	2
Scribbling "	11
Carding "	18
Spinning mule	5
Bobbin waste machine	3
Other textile machines	20
Total	164

during the stages before spinning are recognised in the industry, for example by isolating the machinery in separate buildings, but although this may keep down the direct financial loss of the fires there may be a considerable indirect loss due to interruption of production. The Fire Brigades attended friction spark fires in some cotton mills fairly frequently: at one mill there were twenty attendances in twelve months and at several other mills there were more than five attendances during the year. The importance of the financial loss caused by these fairly frequent fires cannot however be estimated from the Fire Brigade reports.

The remaining 164 fires involving machinery, other than textile machinery, are listed in Table 5. The type of machinery by far the most frequently involved was that concerned with grinding and polishing; the nature of the material first ignited by these operations varied widely. If any steps are to be taken to reduce fire hazards due to the production of friction sparks, in machinery other than textile machinery, then grinding and similar operations warrant early consideration. Other causes of sparks were sanding and sawing, mainly of wood, and fans, frequently in extraction ducting.

The wide range of machinery producing friction sparks which led to fires shows that impacts of sufficient energy to cause incendive sparks are a common feature of powered machinery. Although some reduction in the number of fires might be obtained by better design of the machinery this would not be the complete solution and stringent precautions to prevent the accumulation of combustible should also be taken. With machines on which the sparks are produced in an enclosed space a reduction could be made in the local concentration of oxygen, by adding an inerting gas [6].

Table 5

Friction spark fires attributed to machinery other than textile machinery

Machinery	Number of fires
Grinding, polishing, buffing	86
Sanding (wood)	9
Saw (mechanical)	8
Fan	8
Machine tool	7
Boot and shoe manufacture	6
Dry cleaning tumbler	4
Electric drill	2
Others	12
Unspecified	22
Total	164

Conclusion

Over 300 fires attributed to friction sparks were attended by the Fire Brigades during the period 1st October, 1955 to 30th September, 1956; this total probably represented about one-third of all fires attributed to friction sparks and mechanical heating attended by the Fire Brigades during this period. In over 90 per cent of the friction spark fires the material first ignited was a solid, usually in a state of fine division.

About 65 per cent of the fires in solids involved textiles and allied fibrous materials, cotton dust being particularly prone to ignition. In other fires the materials frequently involved were wood and leather and rubber dusts.

The total number of fires, and also the number of textile fires, showed a pronounced monthly variation and appeared to attain a peak during the spring.

The source of the friction sparks was usually powered machinery and in about half the incidents was machinery used in textile manufacturing. The number of fires attributed to non-powered hand tools and the movement of heavy objects was only about 2 per cent of the total; the materials first ignited in these incidents were not typical of those in the majority of incidents and frequently contained strong oxidising or reducing agents.

Acknowledgment

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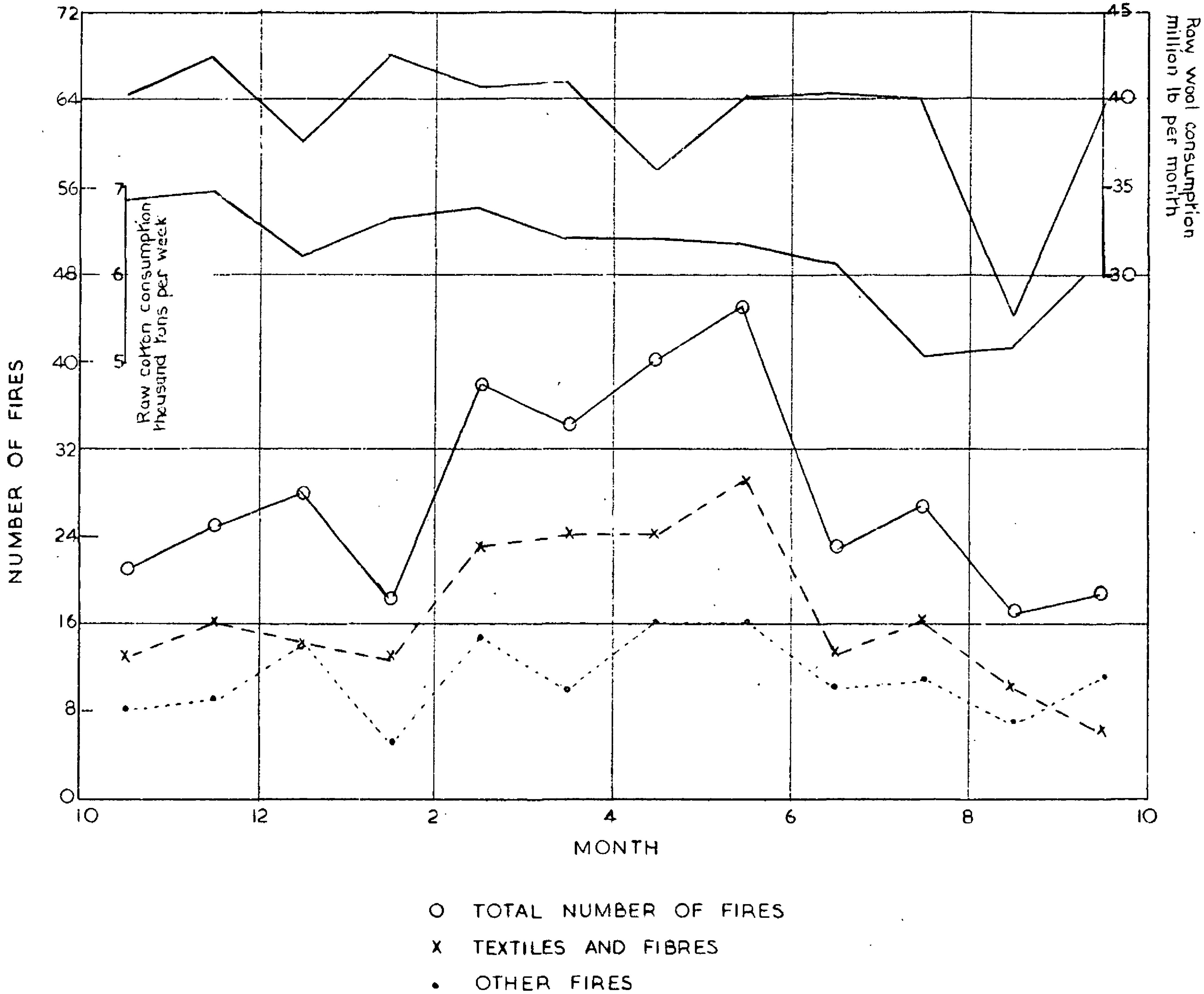

FIG. 1. FIRES DUE TO FRICTION SPARKS OCCURRING BETWEEN 1-10-55 — 30-9-56