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

PROTECTIVE CLOTHING FOR AIRCRAFT CRASH RESCUE WORKERS

PART VII BOOTS

by

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Summary

Samples of footwear have been tested to determine their suitability for use as protective clothing for aircraft crash rescue workers. An interlining of asbestos string increases the protection considerably.

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REPORT ON A SPECIAL INVESTIGATION ON THE PROTECTION AFFORDED AGAINST FIRE OF A PROTOTYPE AIRCRAFT CRASH RESCUE BOOT

1. Introduction

When an aircraft crashes a fire may occur and increase the difficulties of rescuing the occupants. The rescue workers are exposed to high intensity radiation and flame licks from pockets of fire; their present clothing does not give them adequate protection so special clothing has been designed for them.

This report describes an investigation on a prototype boot. The upper part of the boot was of white leather, flesh side out, with inter-linings of open weave asbestos cloth backed by aluminium vynide laminate and an inside lining of white chrome goatskin. This part alone was tested, as the thickness of the sole would necessarily give greater protection against heat.

The test was devised to simulate the worst possible conditions that might be experienced by the wearer; the boot immersed in the flames. A section of the boot was therefore brought into contact with flames from a petrol fire. The maximum temperature that the skin may reach without suffering a burn was stated* to be 60°C, a temperature rise of the skin of about 25°C. The protection given by the boot has been measured in terms of the time taken for the temperature of the unexposed face of the boot to rise 25°C. The flesh acts as a heat sink which reduces the temperature rise and it was simulated by horsemeat.

2. Test apparatus and results

A sketch of the apparatus used in the experiments is shown in fig. 1. The board A has a hole in which a square frame B fits, holding a specimen $1\frac{5}{8}$ in. square in position flush with the surface. The board was placed in position over a metal tray containing enough petrol to burn uniformly for about 10 minutes. The unexposed face was protected from the flames by an asbestos board C.

The temperature rise of that face of the specimen which would be in contact with the skin was measured by a 28 S.W.G. copper-constantan thermocouple, and when it reached 25°C, the petrol fire was extinguished and the further rise in temperature recorded.

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* Letter from Ministry of Supply - 18th January, 1954. This states that contact with any material which is at a temperature of 60°C is likely to cause pain, and ultimately damage to the skin.

Since this work has been carried out, further information has been received (1). The temperature at which unbearable pain may be felt may be as low as 45°C. However, in living tissue, heat is conducted away from the blood, and since dead meat has been used in these experiments a higher temperature may be permissible. A temperature rise of 25°C has been the particular value taken in this report and changing it will not alter the relative order in which the various systems are ranked.

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CONTINUATION

Preliminary tests showed that the thermal resistance of the prototype boot was far higher than that of a standard service boot and of a Wellington boot and most of the tests therefore have been carried out on this boot or on a modified form of it.

Normally, socks would be worn over the foot and these were simulated by two thick layers of knitted wool.

The table below gives the results for the different types of specimens used. In column three the maximum temperature rise recorded during the experiment is given.

Table 1

Specimen All tested with 2 pairs of socks unless otherwise stated.	Time for temperature rise of 25°C Min sec	Maximum temperature rise
Prototype	3 00	37°C in a further minute
Prototype (without socks)	2 35	45°C in a further 2 min 45 sec.
Prototype (without socks, no flesh inside boot)	0 55	Temperature fell immediately.
Prototype (with aluminium layer removed)	3 05	37°C in a further 2 min 30 sec.
Prototype (without aluminium but with 2 layers of asbestos cloth)	4 10	39°C in a further 3 min 30 sec.
Prototype (with inner layers replaced by 2 layers of open knitted wool)	4 05	39°C in a further 4 min 0 sec.
Prototype (with aluminium layer on outside)	3 45	
Prototype (with additional layer of ¼ in. asbestos millboard)	3 25	53°C in a further 4 min 0 sec.
Two layers of service boot leather (with inter-layer of asbestos cloth, no socks)	2 25	35°C in a further 2 min 0 sec.

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3. Conclusions

It is important in designing a boot for use in aircraft crash rescue work to note that:-

1. Aluminium vynide laminate is of no use as an interior layer, but is effective as an exterior coating.

2. There is little difference between the protection offered by white leather and goatskin or two layers of leather from the service boot.

3. Increasing the number of inner layers of asbestos cloth increases the protection time; the prototype boot with an extra layer of asbestos cloth in place of the aluminium foil was the best combination tested, but the asbestos cloth may be replaced by wool.

4. The temperature of the foot continues to rise after the boot has been removed from the flames. Thus the time for which the boot may be worn is rather less than the time given in column 2 of Table 1.

5. In view of the uncertainty of the thermal relation between living and dead tissue the above results should be regarded as comparative only.

Reference

(1) Pesman, G. J. Appraisal of hazards to human survival in airplane crash fires. N.A.C.A. Tech. No. 2996. Washington, Sept. 1953.

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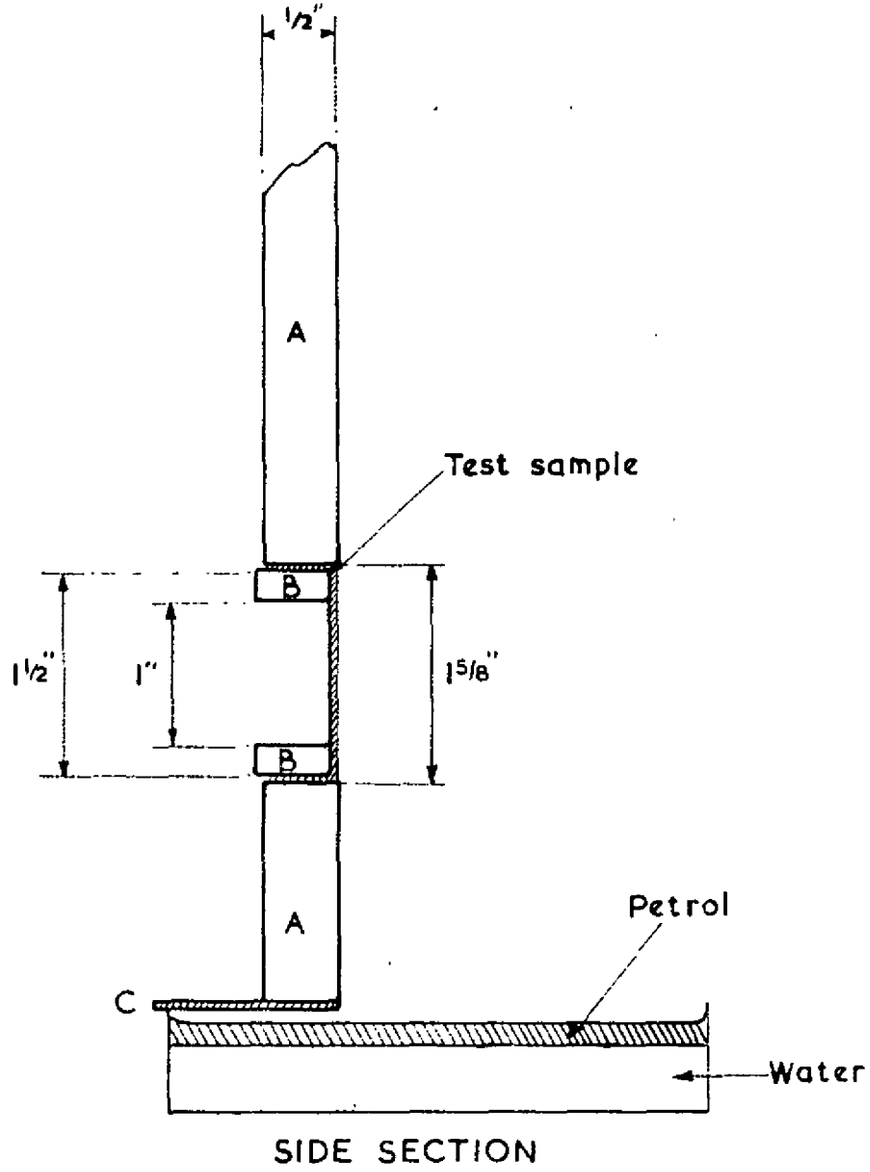

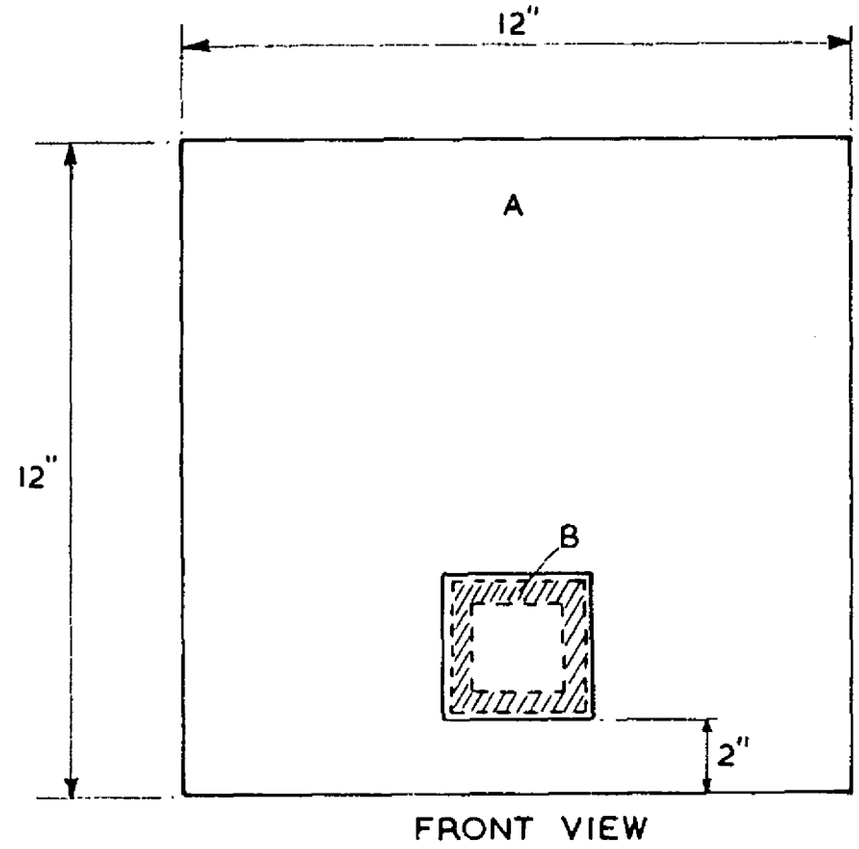

FIG. I. TEST APPARATUS