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

THE FIRE HAZARD OF AIRING CUPBOARDS SURROUNDING FLUE PIPES IN CARAVANS

by

Margaret Law, J. H. McGuire and C. R. Theobald

Summary

Because of the many fires which have occurred in the past in airing cupboards surrounding flue pipes in caravans, an examination has been made of two improved flue arrangements, one which is in common use and another which is a proposed modification of it.

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1. Introduction

A number of fires in caravans have been caused by the use of airing cupboards heated by flue pipes, where the contents of the cupboards were not sufficiently protected from the hot surface of the pipe.

The National Caravan Council has suggested a form of construction intended to eliminate the risk of fire, and this design is being considered by a British Standards Sub-Committee (SFE/13/6), for inclusion in a proposed British Standard on Caravan Heaters.

This note describes an experimental investigation which appears to indicate that this arrangement is not altogether satisfactory. A modification is proposed, giving a reduction in the hazard.

2. Description of designs tested

(a) National Caravan Council design

The arrangement of the flue pipe and airing cupboard suggested by the National Caravan Council is illustrated in Figure 1 and Plate 1.

The 4 inch diameter flue pipe, of 18 S.W.G. galvanised iron, was surrounded over 1 ft. 6 in. of its length by a $\frac{3}{8}$ in. thick asbestos-cement pipe of $5\frac{1}{2}$ in. nominal internal diameter. Only the top and bottom of the airing cupboard and the expanded metal shield were built around the asbestos pipe for the test installation, since in the presence of clothing the outside walls of the cupboard are thermally unimportant. Clothes in the airing cupboard were represented by rags loosely packed round the expanded metal shield. Thermocouples were installed as shown in Figure 1.

(b) Modified arrangement

The modified arrangement is illustrated in Figure 2 and differed from the previous one in that an additional iron shield had been incorporated between the flue pipe and the asbestos cement pipe, the internal diameter of which was increased to 8 inches to maintain adequate separations. The top of the airing cupboard was of $\frac{1}{4}$ in. asbestos wood and a thermocouple was placed between it and the asbestos cement shield.

3. Test conditions

L. L. Fox (1) observed temperatures of 900°C at the lower end, and 700°C at 5 feet above the lower end, of a 6 inch metal flue pipe surrounded by a ventilated 8 inch metal pipe and mounted on an openable stove, burning coal and running with the firedoors closed and ashpit door open. Another report (2) records a temperature of 600°C one foot above the base of a 6 inch unprotected metal flue pipe mounted on an openable stove. This temperature was reached when the fire doors were closed and only 6 minutes after the ashpit door had been opened. The fuel used was coal. Repeating the test with coke a temperature of 540°C was attained 12 minutes after the ashpit door was opened. In both these tests the flue temperature was still rising at these times but no further measurements were taken. In a further test on a domestic boiler burning coal and described in the same report, a temperature of 600°C was attained on a 5 inch metal flue pipe, one foot above the appliance, when the latter was operated with the flue damper and the lower air control open. It therefore seems reasonable to expect that a temperature of the order of 500-550°C could occur when domestic appliances are overloaded as may happen in cold weather.

To represent these conditions, the experimental flue pipe was heated internally by a gas poker providing a constant heat source such that equilibrium flue pipe temperature rises of the order of 550°C were attained.

In the tests described in the following paragraphs all temperatures were measured by means of 26 S.W.G. chromel-alumel thermocouples and a Cambridge potentiometer.

4. Test results

(a) National Caravan Council design

A temperature record of the test together with a statement of the behaviour of the assembly is shown in Figure 3. Although fire did not break out until 43 minutes had elapsed, smoke was issuing from the rags and there was a strong smell of scorching after only 15-17 minutes when the top of the expanded metal shield, which was in contact with the rags, had risen in temperature by 187°C. After 18 minutes the wooden top in contact with the asbestos cement shield was scorched.

(b) Modified design

The temperature record of the test is given in Figure 4 and shows that equilibrium conditions were reached in about 90 minutes. After $3\frac{1}{2}$ hours the temperature rise of the top of the expanded metal shield was 75°C, and the rags were not scorched. The temperature rise at the point where the top of the cupboard came in contact with the asbestos cement shield was 98°C.

Conclusions

The first arrangement tested, which conforms to the recommendations of the National Caravan Council, presents a considerable fire hazard although, of course, less than that of an airing cupboard surrounding an unprotected flue pipe.

Modification of the design to incorporate an additional metal shield between the flue pipe and the asbestos cement shield, as shown in this report, reduces the hazard to a level which appears to be acceptable. The use of asbestos wood as the top of the airing cupboard might be advisable.

References

1) Lawson, D. I., Fox, L. L. and Webster, C. T. "The heating of panels by flue pipes". Department of Scientific and Industrial Research and Fire Offices' Committee, Joint Fire Research Organization. Special Report No. 1. London, 1952, H.M.S.O. P. 8, Fig. 5.

2) Fox, L. L. and Whittaker, D. "Flue temperatures obtained with some domestic solid fuel appliances". Department of Scientific and Industrial Research. Fuel Research Station Report Reference DFR 17/60/36.

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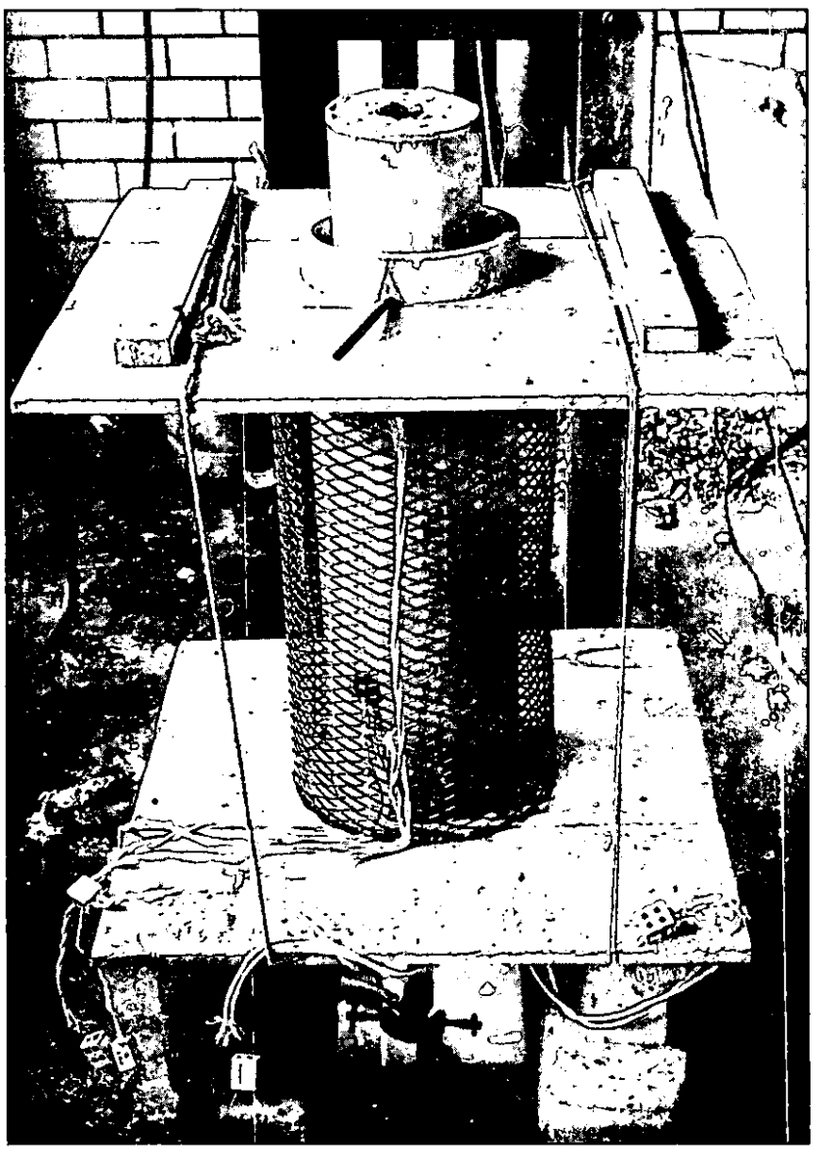

PLATE. I. ARRANGEMENT CONFORMING WITH N.C.C. RECOMMENDATIONS

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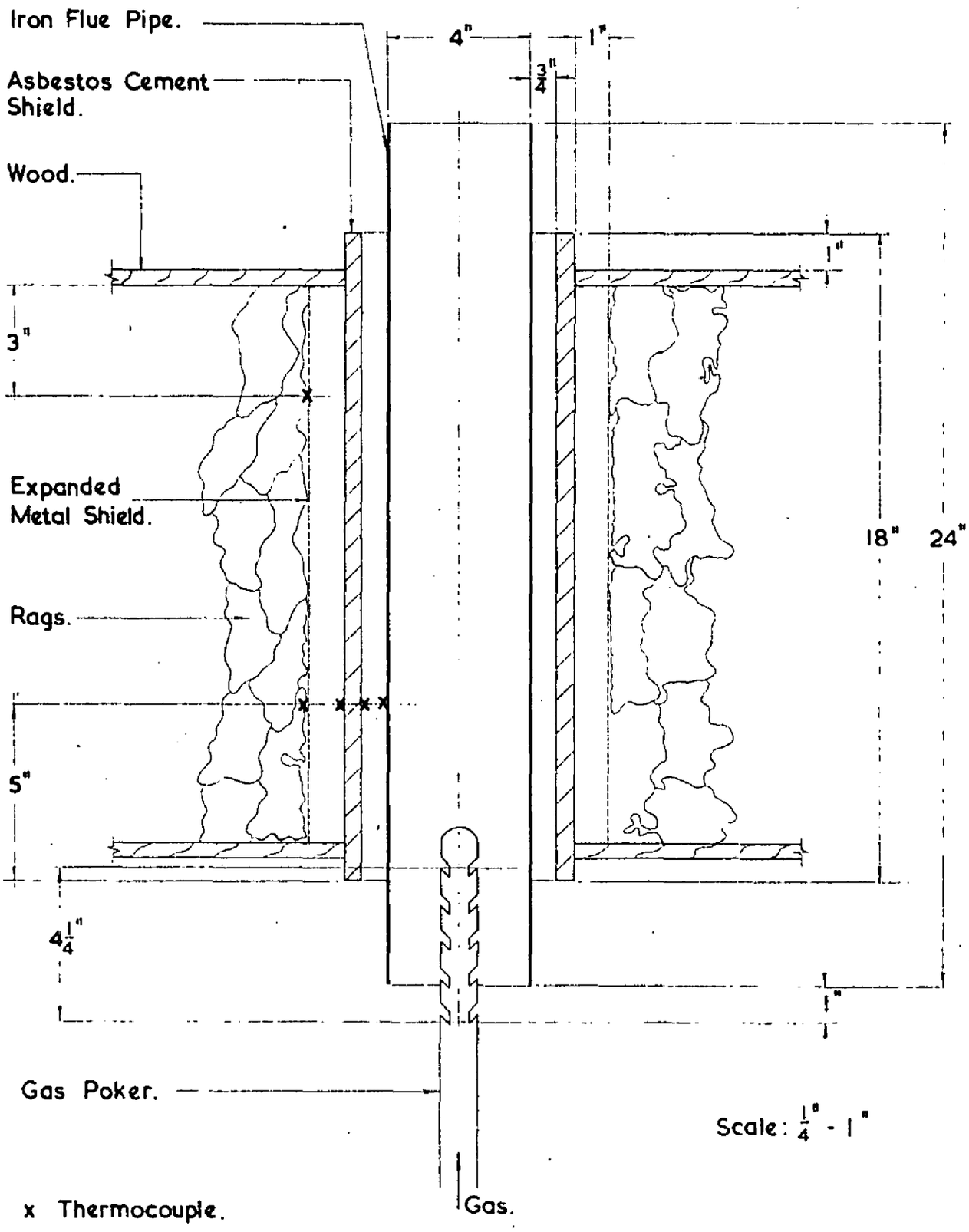


FIG. 1. ARRANGEMENT CONFORMING WITH N.C.C. RECOMMENDATIONS.

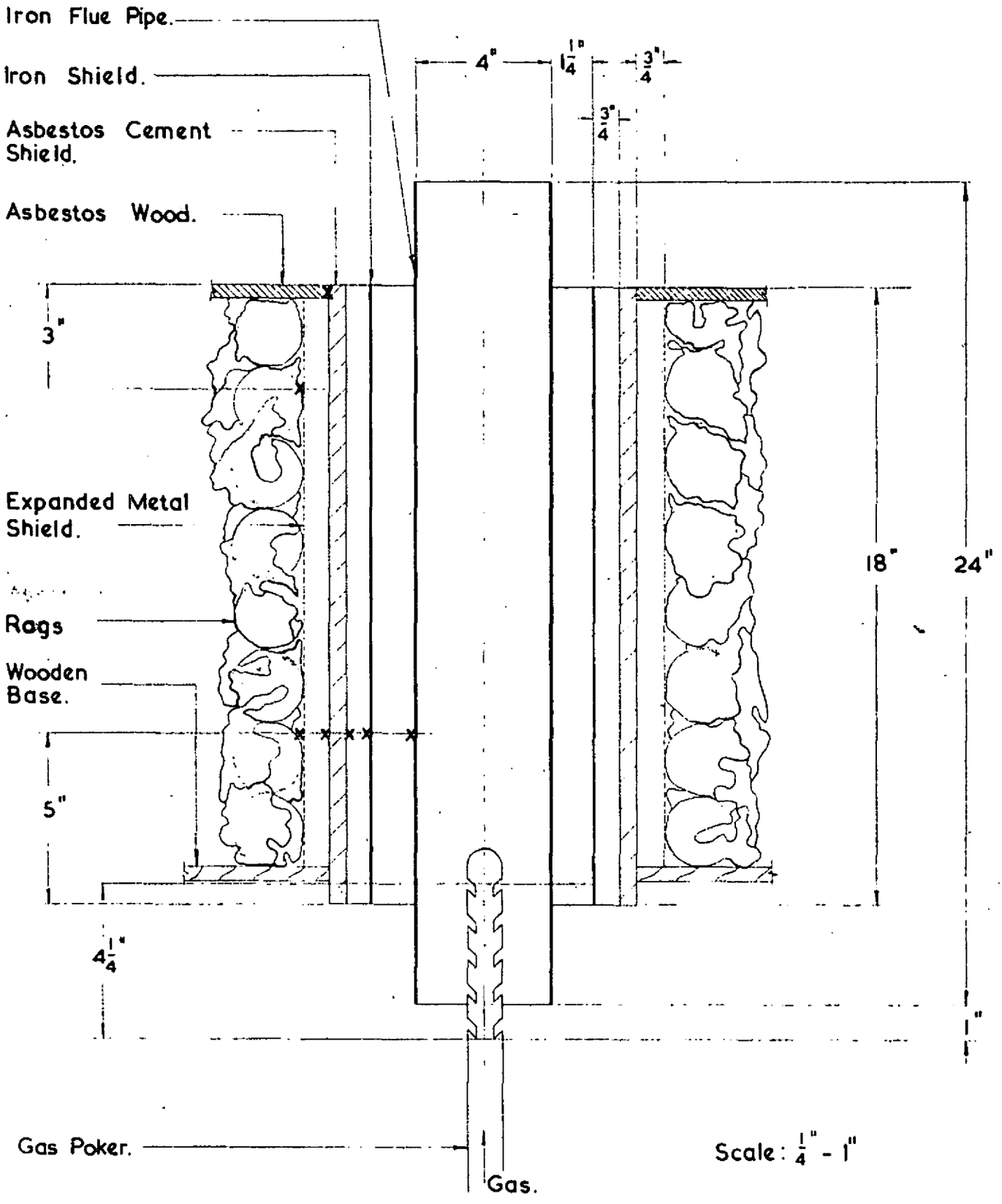
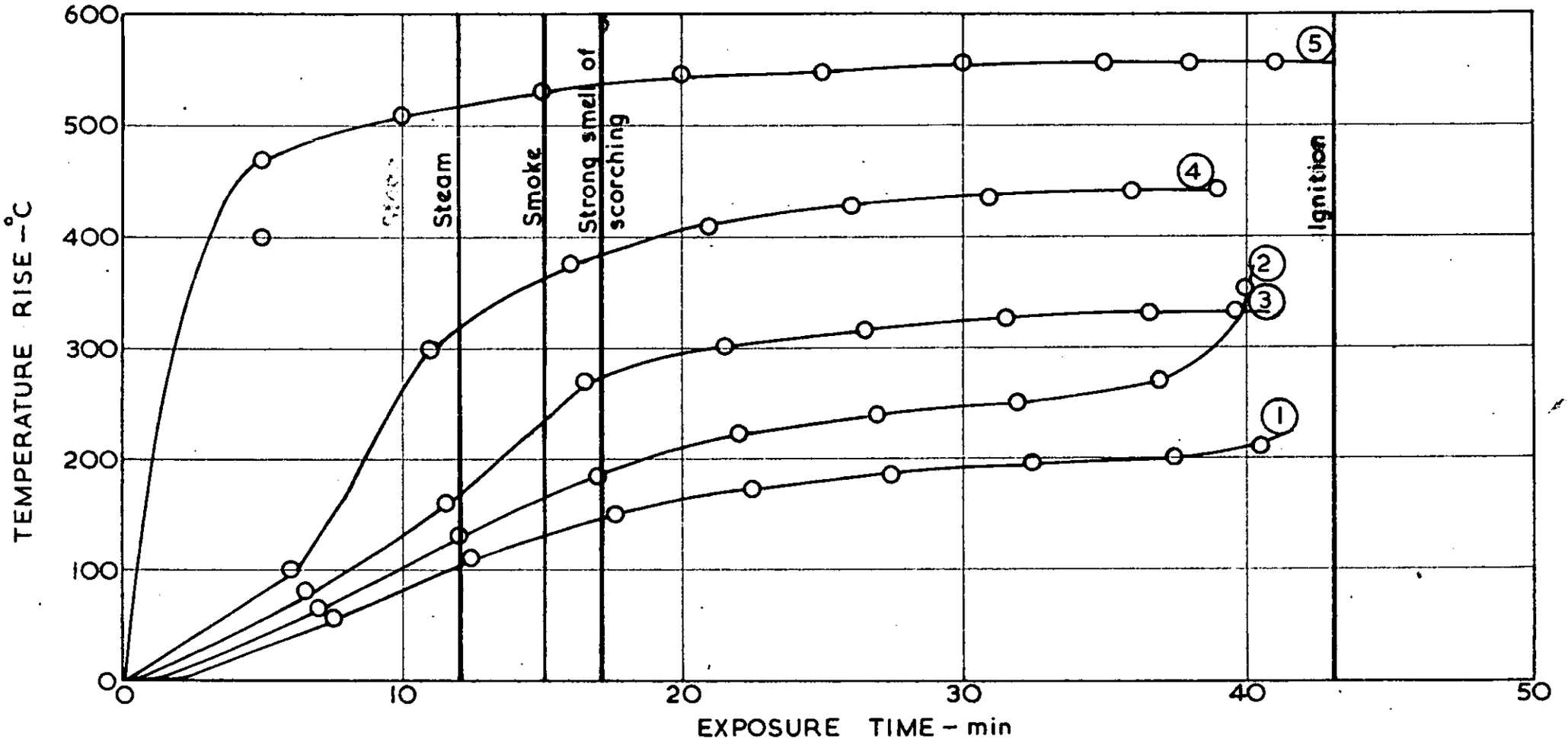
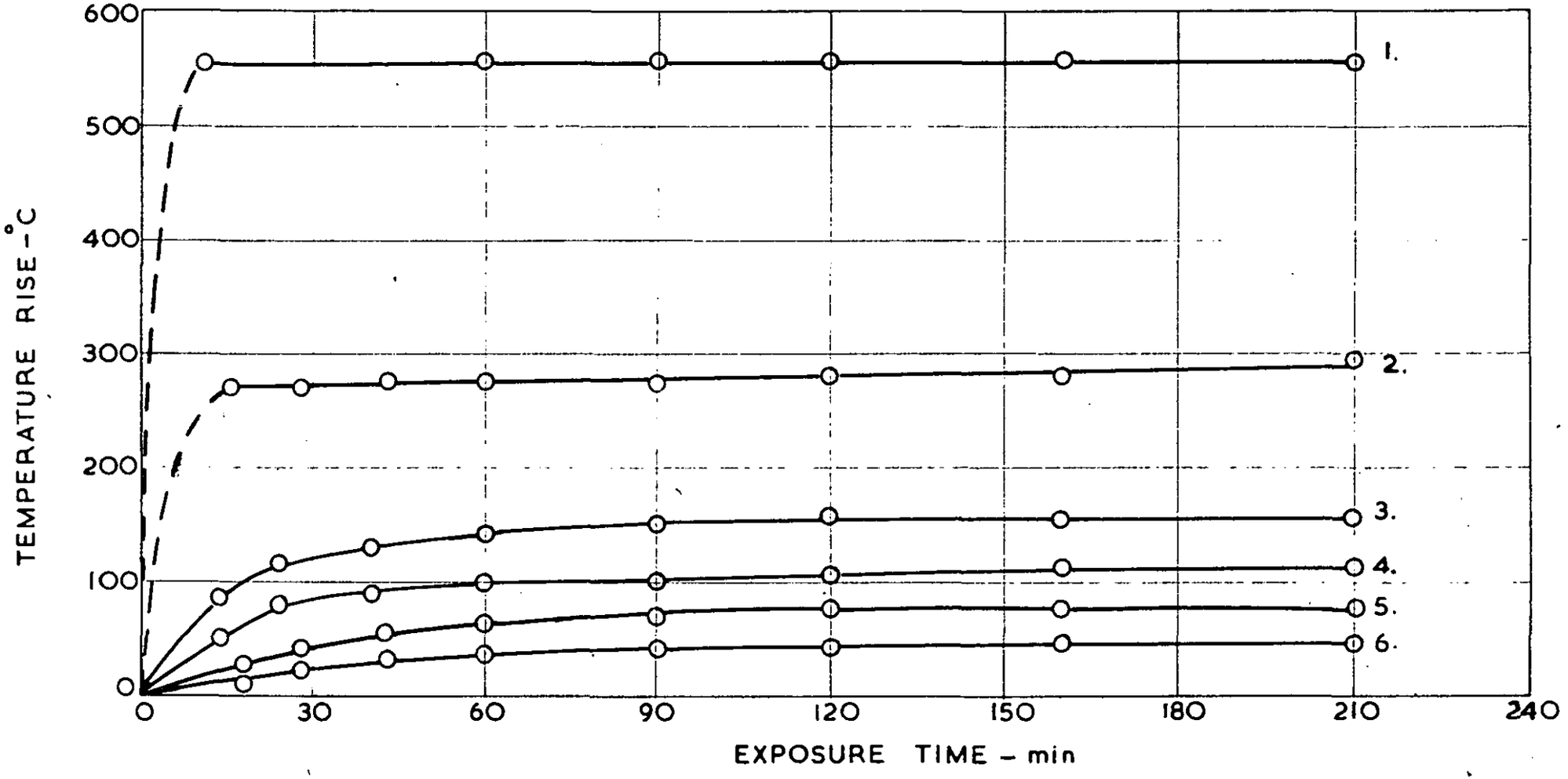


FIG. 2. MODIFIED ARRANGEMENT.



1. Bottom of expanded metal
2. Top of expanded metal
3. Outer surface A.C. shield
4. Inner surface A.C. shield
5. Flue pipe

FIG.3. TEMPERATURE RECORD OF TEST ON ARRANGEMENT CONFORMING WITH N.C.C. RECOMMENDATIONS



1. Flue pipe
2. Iron shield
3. Inner surface A.C. shield
4. Outer surface A.C. shield
5. Top of expanded metal
6. Bottom of expanded metal

FIG 4 TEMPERATURE RECORD OF TEST ON MODIFIED ARRANGEMENT