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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
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REPORT ON AN EXPLOSION IN A PETROL TANK AT THE IRONBRIDGE SERVICE STATION, SOUTHALL

by

D. J. Rasbash and Z. W. Rogowski

Summary

An explosion occurred in a petrol tank while a vent pipe was being cut with an oxyacetylene cutter. The tank had been emptied 27 years ago and not used since. The incident emphasizes the importance of taking full precautions before carrying out work on a tank which has contained flammable liquid.

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File No.

Fire Research Station,
Boreham Wood,
Herts.

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Introduction

An explosion occurred in a petrol tank at the Ironbridge Service Station, Southall, at 2.15 p.m. on 3rd January, 1955. The scene of the explosion was visited by the Authors accompanied by Mr. Squire of the Middlesex Fire Brigade on the morning of 4th January.

Description of the tank

The tank, which was sunk in the ground, had been shattered by the explosion but an examination of the wreckage indicated that prior to the explosion the design of the tank was as shown in figure 1. It was a cylindrical steel shell 6 ft. in diameter and 10 ft. long and its capacity was given as 1,000 gallons. The thickness of the metal was $\frac{1}{4}$ in. and the sheets were butt welded. Two pipes, about $1\frac{1}{2}$ in. internal diameter reached down to the bottom of the tank at one end. Presumably these pipes were used for filling and determining the level of the liquid in the tank. At the top of the other end was a vent hole attached to a length of venting pipe 1 in. internal diameter.

The tank was one of a group of four, three of a 1,000 gallon capacity and one of 500 gallons. The relative positions of these tanks are shown in figure 2, which was obtained from information provided by Mr. Squire after our visit to the scene of the explosion. The tank which exploded is marked as tank 2. The vent pipes from each of the four tanks ran underground for a distance of some 20 to 30 ft. before rising vertically to a height of 7 ft. There was a connection between the level measuring tubes of the 500 gallon tank (tank 1) and tank 2. The tanks were stated to have been installed in concrete chambers with a 9 in. base and 6 in. sides and top and packed with puddled clay.

The tanks were installed by the Anglo-American Company in 1925. They were in use until 1927 when the Company records indicated that they were filled with water. The present owners obtained possession of the site about four years ago.

Circumstances of the explosion

The explosion occurred while a workman was cutting away with an oxyacetylene cutter that part above the ground of the vent pipe of tank 1. As a result of the explosion the whole of the concrete directly above the tank 2 was shattered and pieces were thrown as far as 150 ft. Several pieces fell on a neighbouring main road. The sheet of metal forming the top of tank 2 was blown off and the tank was burst at the weld seams in a number of places. A small fire in the bottom of the tank followed the explosion; this fire was extinguished with foam extinguishers. There were no casualties.

Small quantities of petrol were found in the foam. A sample collected for examination gave the distillation curve shown in figure 3. The curve indicates a normal petrol, except for the fact that the initial boiling point is somewhat higher than usual. This indicates, as might be expected, that some of the lighter fractions had evaporated from the original liquid. The liquid was easily ignited at room temperature by a small gas flame.

When we visited the scene we were not aware of the fact that tank 1 intervened between the vent pipe which had been heated by the oxyacetylene torch and tank 2 which exploded. We therefore did not look particularly for damage in the neighbourhood of this tank. Mr. Squire, however, has since informed us that there was no sign of damage to the concrete near tank 1. Moreover, this tank has since been filled with water; this operation is said to have resulted in the expulsion of petrol fumes through the vent pipe which had been cut.

Propagation of flame to the tank

From the available evidence it appears that flame propagated through the vent pipe that was being cut and tank 1 and thence through the level-measuring pipe to tank 2. However, under these conditions it would normally have been expected that tank 1 would have shown signs of damage. An explanation may be that the mixture in this tank was so near the limit of flame propagation as not to result in a rise in pressure sufficient to cause damage. It is clear, however, that if this was indeed the way the flame travelled then at least tank 2 and probably tank 1 was almost empty of water at the time of the explosion since the level measuring tube along which the flame travelled reached down to the bottom of the tanks. This indicates that the water had leaked away during the period of 27 years since filling. An alternative method of flame travel may have been directly through the vent pipe of tank 2. This was not so likely, however, since it was stated that the oxyacetylene torch was not played on this vent pipe.

Explosive atmosphere in tank

The chief item of practical interest in this incident was the fact that after the tank had been emptied, filled with water and allowed to stand for 27 years, there was not only an explosive atmosphere but also some liquid petrol left in the tank. After emptying a tank of this nature, some liquid is usually left, chiefly because the feed pipe does not quite reach to the bottom of the tank. There are two mechanisms whereby the remaining liquid may have evaporated in the course of time. Firstly, by diffusion through the vent pipe, and secondly by "breathing" through this pipe; the latter effect is caused by expansion and contraction of the gas in the tank due to changes in temperature. With a vent pipe of the length that existed in this particular case the diffusion evaporation would have been negligibly small. A calculation has indicated that this mechanism would allow only approximately 0.1 gallons to be evaporated in the course of 27 years. The evaporation which can take place as a result of breathing can vary very widely. Some information has been given by Schmidt (1) on the losses during the Summer months from 10,000 gallon over ground tanks in the United States. These losses varied from 0·01 to 0·03 per cent of the tank contents per day, the loss decreasing as more protection was provided against solar radiation and external temperature changes. However, since the conditions in the present case were so different, it would be unwise to use these values to give an estimate of the breathing loss.

Conclusions

It is clear that after a lapse of 27 years since being emptied and filled with water, a petrol tank not only contained an explosive atmosphere but also some liquid petrol. Moreover the water had leaked away. This incident, therefore, emphasizes the importance of taking full precautions, as laid down in the Factories Acts 1937 Section 28 (4) and 1948 Section 11 (4), before carrying out work on a tank, or a pipe leading from a tank, which has at one time contained flammable liquid.

Reference

(1) The Science of Petroleum. Oxford Univ. Press. Vol. I. p. 831.

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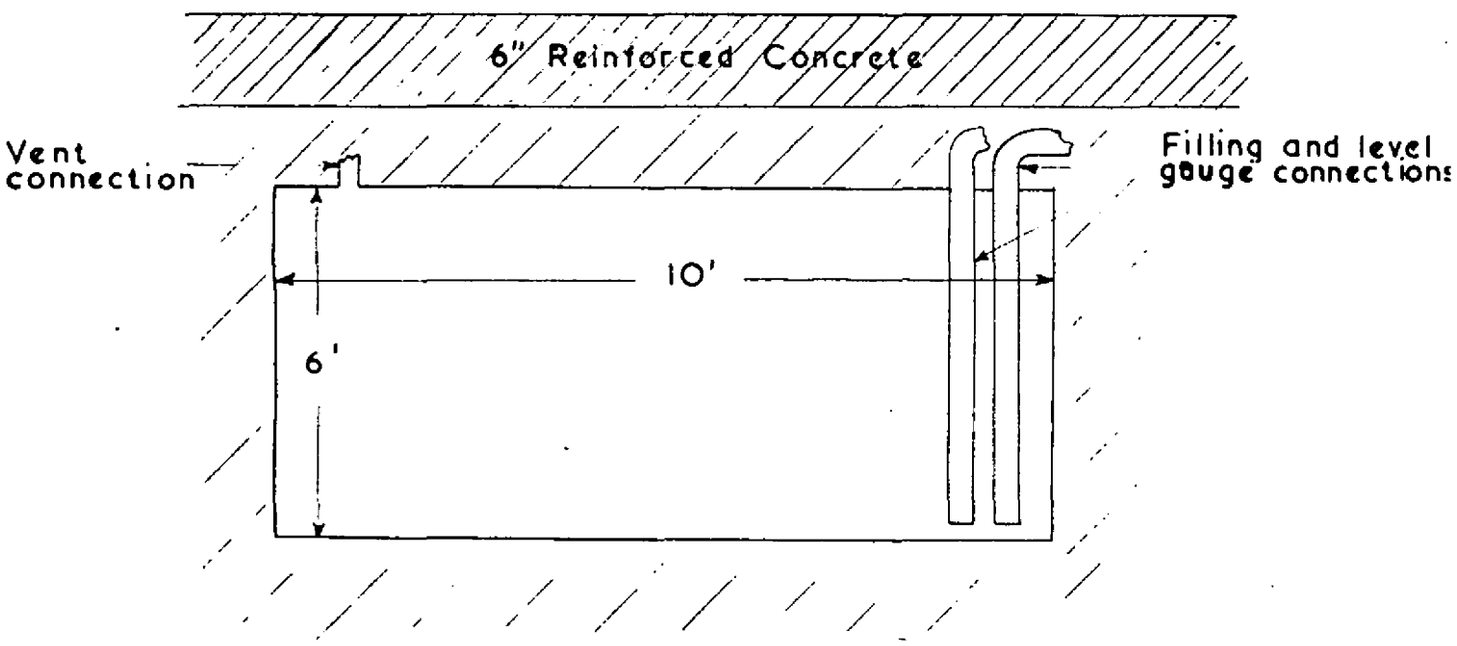

FIG. 1. PROBABLE LAYOUT OF THE TANK BEFORE THE EXPLOSION.

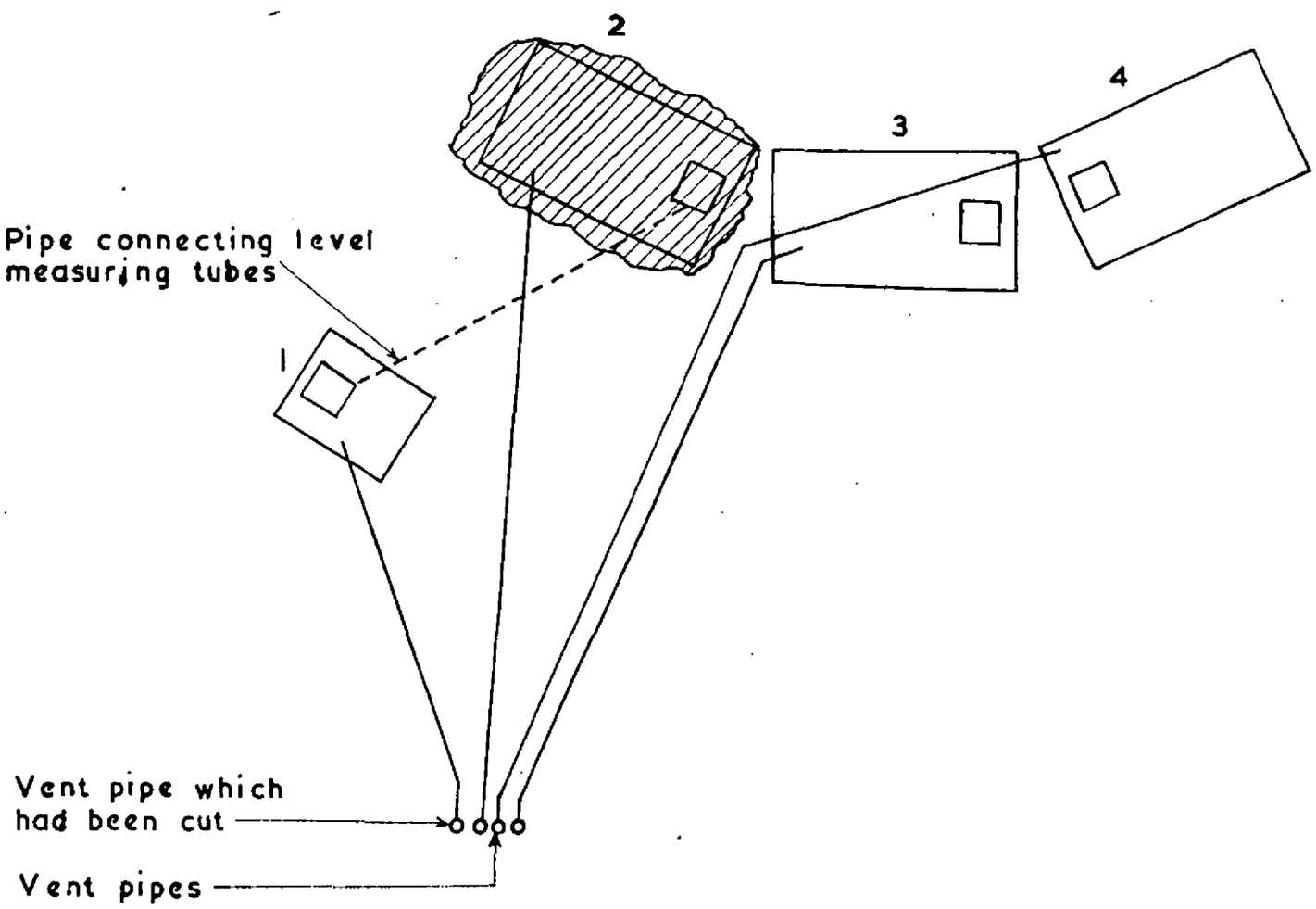

FIG. 2. RELATIVE POSITION OF TANKS ON THE SITE.

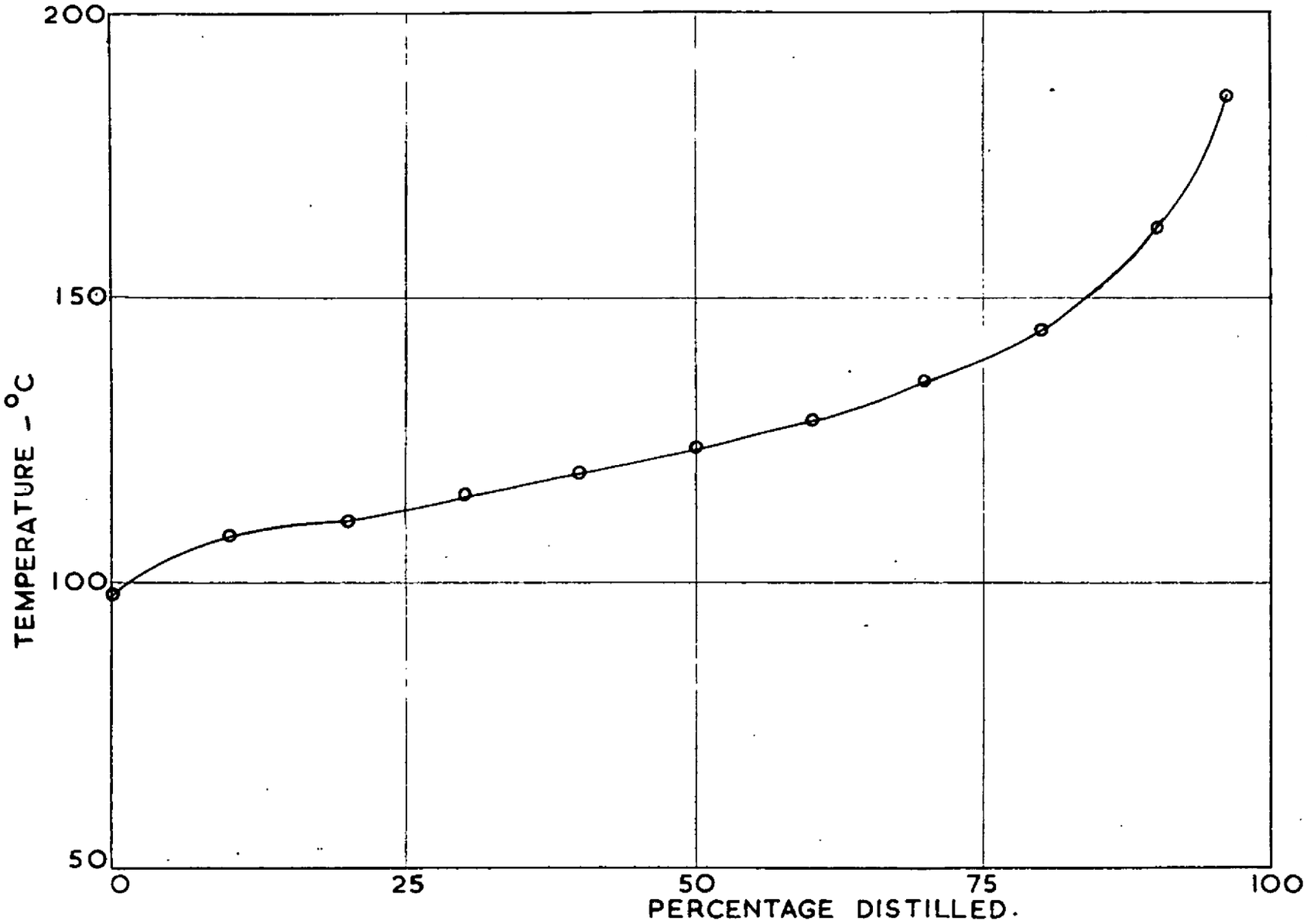

FIG. 3. DISTILLATION CURVE FOR THE LIQUID COLLECTED FROM THE TANK