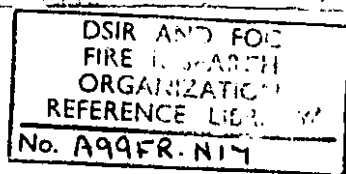


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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE  
JOINT FIRE RESEARCH ORGANIZATION

FIRE RESEARCH BOARD

Vaporizing Liquid Extinguishing Agent Committee

The attached report F.R.17 of trials of trifluorobromomethane extinguishers must be regarded as strictly confidential.

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REPORT ON DEMONSTRATION OF FIRE EXTINGUISHING AGENTS AT  
JOINT FIRE RESEARCH ORGANIZATION, BOREHAM WOOD.  
12th JUNE, 1952.

Introduction

Laboratory investigations of the inflammability limits of combustible vapours with halogenated paraffin hydrocarbons, carried out in U.S.A. and in this country, have indicated that certain fluorinated compounds containing bromine were more efficient extinguishing agents than existing materials, and were also far less toxic. Because of this combination of desirable properties, it became necessary to consider the possibility of replacement of existing installations in service equipment, by these newer agents, of which the most promising appeared to be (1) trifluorobromomethane ( $\text{CF}_3\text{Br}$ ) and (2) difluorodibromomethane ( $\text{CF}_2\text{Br}_2$ ).

The Army Fire Service recently obtained a supply of trifluorobromomethane from the U.S.A. Military authorities and requested the Joint Fire Research Organization to arrange a demonstration for the British Service departments to compare it with other agents under more practical conditions than those of the laboratory tests.

A limited series of trials was carried out therefore at the Joint Fire Research Organization, Boreham Wood, and the extinguishing agents were demonstrated on 12th June, 1952.

Experimental Extinguishing Agents

The agents compared were, carbon dioxide, carbon tetrachloride, methyl bromide and trifluorobromomethane. The containers and apparatus from which they were applied are given in the table, which also gives details of the physical properties of the agents.

Test fire

The test fire consisted of 2000 m.l of petrol burning on the surface of a 4 in. depth of water contained in a 2 ft. diameter tray. This fire reached the maximum intensity about five seconds after ignition, and burned strongly for two minutes. Since the average time of discharge of the extinguishers was less than one minute, this two minutes fire was ample for observing the effects of the extinguishing agent.

Application of extinguishing agent

The agents were applied from commercial forms of apparatus. In order to eliminate any variation due to differences in the efficiency of the operator, the application was made mechanically. The extinguishers were mounted on an oscillating turntable which gave a traverse of approximately  $60^\circ$  at 60

oscillations per minute. The position was adjusted so that the jet from the extinguisher struck the centre of the petrol surface at an angle of about  $30^{\circ}$ . The apparatus is shown in Fig. 1. It is realized that this is not necessarily the most efficient mode of application for every extinguisher but it was considered to give a reasonably accurate comparison between the different agents.

#### Method of test

The tests were made in an enclosed building 18 ft. x 20 ft. 6 in. x 9 ft. 6 in. high, so as to eliminate effects due to wind. Observations were made through safety glass windows, and also through partially opened doors. The extinguisher under test was weighed, mounted on the turntable, the apparatus was placed in the required position relative to the fire, the measured amount of petrol poured on to the water and ignited, and after it had burned for 10 seconds the extinguisher was operated and the turntable motor switched on. Observations were made of the behaviour of the fire, the time taken for extinction, and the time of effective discharge of the extinguisher. After the trial the extinguisher was weighed again. The fire was relit and allowed to burn out so as to vaporize the remainder of the extinguishing agent, which would otherwise be retained in the petrol, or would have interfered with subsequent tests. The results of the trials are given in the table.

#### Discussion of results

Carbon tetrachloride The carbon tetrachloride was applied from a "strike the knob" extinguisher pressurized with  $\text{CO}_2$  and issued as a jet, which appeared to go below the surface of the burning petrol without producing much reduction of intensity of the fire, although there was an increase in the density of the smoke from the fire. Carbon tetrachloride is a liquid boiling at  $76.8^{\circ}\text{C}$  and is thus not notably volatile. It is considered that this agent might have been more efficient if it had been applied as a spray. After the trial the atmosphere was very smoky and acrid.

Carbon dioxide The carbon dioxide was applied through a horn from a screw-down valve extinguisher. It reduced the intensity of the fire considerably and had the discharge continued a little longer might have extinguished the fire.

The atmosphere in the test house was more tolerable with this than with any of the other agents. During preliminary tests, with the extinguisher held in the hand, the fire was extinguished in 33 seconds. In subsequent trials, when more experience had been gained, the fire was extinguished in 9 seconds.

Methyl bromide Methyl bromide was applied from trigger operated extinguishers. These required the insertion of a device to maintain the valve in the open position during test and the procedure for this agent was, therefore, modified by opening the valve before the 10 second interval had elapsed and then wheeling the apparatus into position at 10 seconds. The methyl bromide was ejected as a spray which rapidly filled the container with heavy vapour, and the petrol vapour burned for a short time above this. The atmosphere after extinction was acrid but less smoky than with carbon tetrachloride.

Trifluorobromomethane The trifluorobromomethane was supplied in extinguishers normally used for carbon dioxide. The apparatus was operated by a screw-down valve and the compound was delivered through a discharge horn. It was noticed that in the early stages of the application a liquid dripped from the end of the horn. This may have been liquid compound or it may

have been water condensed from the atmosphere, similar to the frost found on a discharging carbon dioxide cylinder. As with methyl bromide, the petrol container was rapidly filled with heavy vapour and burning petrol vapour overflowed and burned below the level of the top of the dish. After extinction the atmosphere was faintly acrid, and even less smoky than with methyl bromide.

#### Conclusions

From the results of the demonstration and the trials preceding it, it appears that trifluorobromomethane and methyl bromide are in a similar class and both are far superior to the other agents tested under corresponding conditions. If the best results from these two are compared, trifluorobromomethane is seen to be superior to methyl bromide, whether the comparison is made by time of extinction, weight of compound or volume of vapour.

Extinguishing agent				RESULTS OF EXTINGUISHER TRIALS						Details of Trials					
Compound	Boiling Point °C	Density		Type	Wt of contents g.	Vapour vol of contents l.	Average time of effective discharge sec.	Average rate of discharge		Test No.	Arrangement of apparatus	Time for extinction. Sec.	Quantity of agent used		Remarks
		Vapour N.T.P. g/l	Liquid 20°C g/cm <sup>3</sup>					Wt. g/sec	Vol (vapour) l/sec.				Weight g.	Vol. vapour l.	
<u>Carbon tetrachloride</u> CCl <sub>4</sub>	78.6	6.84	1.60	Pressurized with CO <sub>2</sub> Operated by striking knob.	1320	193	42	31.5	4.6	a	(All extinguishers mounted on turntable except where noted for CO <sub>2</sub> ) Jet struck centre of fire at 60°	did not extinguish	1320	193	No effect on intensity of fire but considerable amounts of smoke evolved. Position of jet made little apparent difference.
										b	-ditto- 30°	"	"	"	
										c	-ditto- back of fire at 30°	"	"	"	
										1.	Jet struck centre of fire at about 40°	"	"	Fire reduced but smoke increased Fumes very acrid from all applications.	
<u>Carbon dioxide</u> CO <sub>2</sub>	-78.5	1.98	-	Compressed gas, operated by screwdown valve and applied through horn.	1705	862	45	37.9	19.3	d	Extinguisher held by operator	31	1176	598	Fire was controlled very quickly but insufficient agent available for complete extinction. Atmosphere tolerable.
										e	-ditto-	9	341	174	
										f	Ext: mounted on turntable, horn at 30°	did not extinguish	1705	862	
										2	Ext: - ditto - As 2 but horn at 15°	"	"	"	
<u>Methyl bromide</u> CH <sub>3</sub> Br.	4.5	4.25	1.73	Liquid pressurized with nitrogen. Extinguisher operated by trigger valve.	1320	452	65	29	7.0	g	Jet to back of fire	45	1305	355	Burning petrol vapour floated above the layer of vaporized agent. The atmosphere was acrid but less smoky than with carbon tetrachloride.
										h	Jet at 1/3 across	33	957	231	
										j	Jet at centre	12	348	84	
										k	Jet at front	19 1/2	565	137	
										4	Jet to centre of fire, AS 4.	extinguisher failed			
<u>Trifluorobromomethane</u> CF <sub>3</sub> Br.	-60	6.66	1.58	Compressed into CO <sub>2</sub> cylinders, screw-down valve to operate. Applied through horn	1270	191	53	26	3.6	l	Horn at 30°	15	390	54	The heavy vapour of the extinguishing agent sank under the burning petrol vapour which was floated away from the fire, Some liquid dripped from the end of the horn. The atmosphere was slightly acrid and slightly smoky.
										m	-ditto-	16	416	58	
										3	-ditto-	7 1/2	195	27	
										7	-ditto- 15°	11 1/2	295	41	

\* Note Letters refer to preliminary trials, Numbers are those of trials on 12th June, 1952.

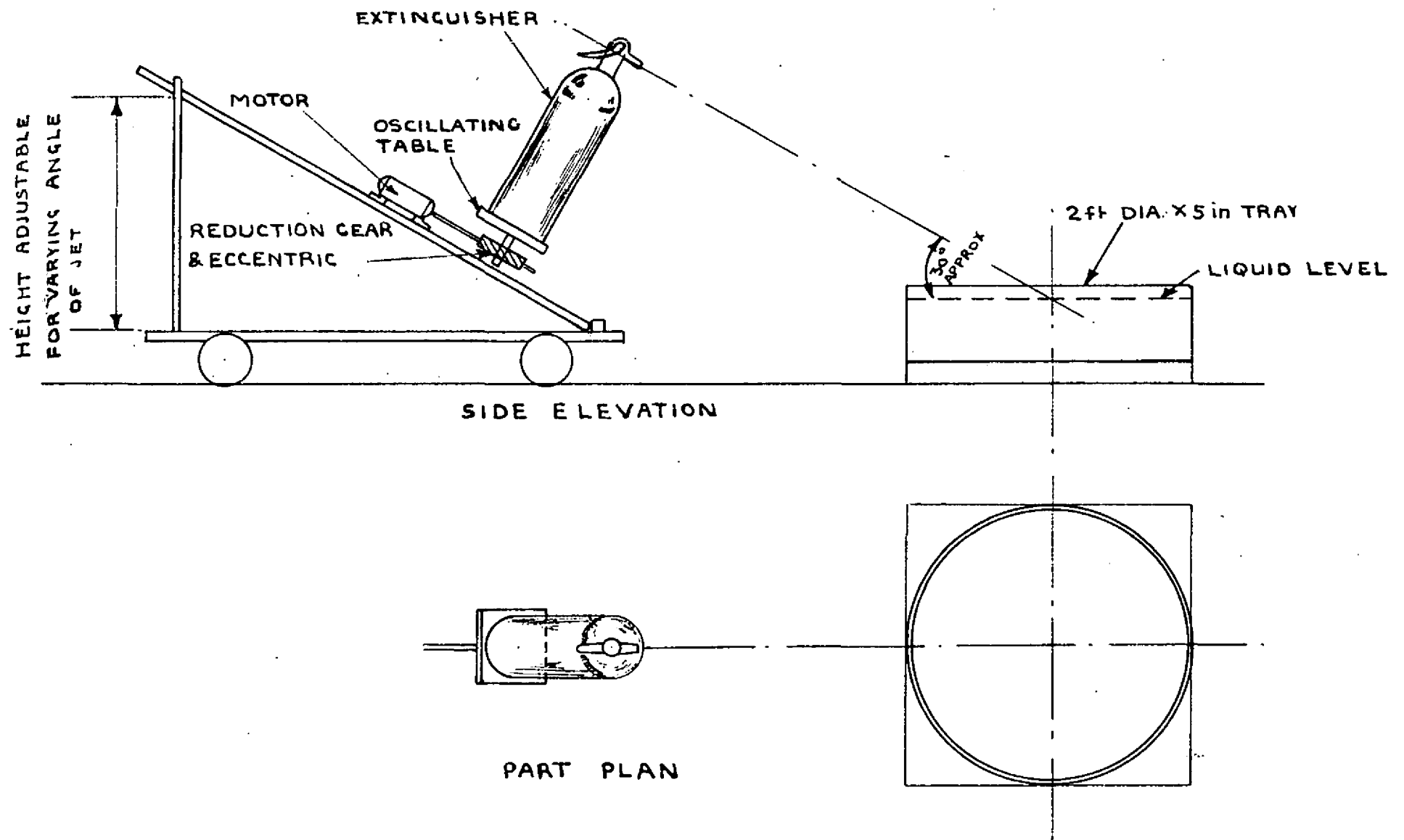


FIG. 1. DIAGRAM OF APPARATUS FOR MECHANICAL APPLICATION OF EXTINGUISHING AGENTS