

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
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THE USE OF WATER IN FIGHTING FIRES IN ROOMS

by

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Introduction

There has been considerable discussion on the merits of high pressure water sprays for fighting interior fires. A further careful examination of the problem has been made and the only large-scale fire tests in which information is available on nozzle pressures, rates of delivery, extinction times and size of fire are listed below:-

1. Tests by National Board of Fire Underwriters in a room of 900 cu. ft. capacity lined with fibre insulating board but unfurnished.
2. Tests carried out at the Building Research Station during the war in furnished living-rooms of 1500 cu. ft. capacity.
3. Similar tests at Ladbroke Grove.
4. Tests carried out by the Joint Fire Research Organization at Birmingham in 1500 cu. ft. rooms similar to those at the Building Research Station.
5. Tests carried out at the Joint Fire Research Organization in a room (500 cu. ft. capacity) lined with fibre insulating board but unfurnished.
6. Tests in dwelling house attic in Connecticut (dimensions of attic not given).

Analysis of results

In many of these tests the degree of ventilation, fire load and size of room were not the same and nozzle pressures varied from 50 to 600 lb/sq.in. However, if the extinction times for all the tests are plotted merely against rate of delivery in g.p.m./1000 cu. ft. of room volume, it can be seen (Figure 1) that the familiar "critical rate" curve is obtained. This indicates very strongly that with fires of this type (dwelling room fires) the one factor of overriding importance is the rate at which water is delivered to the fire, and that nozzle pressure has little importance except in so far as it affects rate of flow.

Practical considerations

In Figure 2 the amount of water used for extinction is plotted against the rate of delivery - the most economical rate being between 20 and 40 gallons per minute per 1000 cu. ft. of room volume. Assuming the average living-room to be about 1500 cu. ft., a satisfactory rate of delivery for this type of fire would be between 30 and 45 gallons/minute. These deliveries can of course be very easily obtained with a spray nozzle on a 2½ in. line with pump pressures of 100 p.s.i.

However, if this type of fire is to be tackled by a first-aid line there is considerable friction in the hose to be overcome. Figure 3 shows the pressure drop due to frictional resistance in a 240 ft. length of ½ in. rubber hose at various delivery rates. For comparison, the pressure loss in a similar length of 1 in. hose is given. From this it can be shown that with a pump pressure of 120 p.s.i. the maximum flow obtained with a 7/16 in. nozzle and ½ in. line is 18 gallons/minute. The maximum with a 1 in. line obtained with a 9/16 in. nozzle is about 32 gallons/minute. It would appear therefore that the first-aid hoses used in conjunction with the normal firefighting pump would give too small a rate of delivery to fight fully developed fires efficiently.

To fix the pump pressure required in rooms it is probably best to decide on the important operational requirements:-

Rate of delivery,
throw of spray,
cone angle of spray.

The chosen values can then be obtained through the first-aid line with a given pump pressure and a given nozzle size. Figure 4 shows the pump pressures required to give a spray of a chosen characteristic at a given rate of flow through 240 ft. of $\frac{1}{2}$ in. hose. Figure 5 shows similar curves for 240 ft. of 1 in. hose. Some examples taken from these curves are given in Table 1. Taking a rate of flow of 30 gallons/minute as being about the minimum for efficient use against a fully developed dwelling room fire, and a suitable spray as one with a cone angle of 30° and a throw of 20 ft. this would require a pump pressure of about 350 p.s.i. with a $\frac{1}{2}$ in. line. A similar performance could be obtained with a pump pressure of 120 p.s.i. with a 1 in. line.

Conclusions

A further examination of the evidence indicates that there is no benefit to be obtained in extinction of dwelling room fires by having a high nozzle pressure.

The most economical rates of flow for this type of fire are between 30 and 45 gallons/minute.

These rates of flow cannot be obtained with a pump pressure of 120 p.s.i. and a 240 ft. first-aid line of $\frac{1}{2}$ in. diameter; a pump pressure of about 350 lb./sq.in. would be required.

The desired rate of flow and performance can be obtained with a pump pressure of 120 lb./sq.in. using 240 ft. of 1 in. diameter hose.

Acknowledgements

Thanks are due to Mr. Gregston for help in computing the graphs in this paper.

Table 1

Pump pressures required for sprays
of various characteristics

Rate of flow g.p.m.	$\frac{1}{2}$ in. line					1 in. line			
	Throw ft.	Cone angle deg.	Pump pressure p.s.i.	Nozzle not less than	Throw ft.	Cone angle deg.	Pump pressure p.s.i.	Nozzle not less than	
10	20*	30*	230*	3/16"	20*	30*	205*	3/16"	
20	20	30	215	5/16"	20	30	110	5/16"	
30	20	30	350	7/16"	20	30	120	7/16"	

*These conditions can be obtained at higher rates and lower pump pressures if a larger nozzle is used.

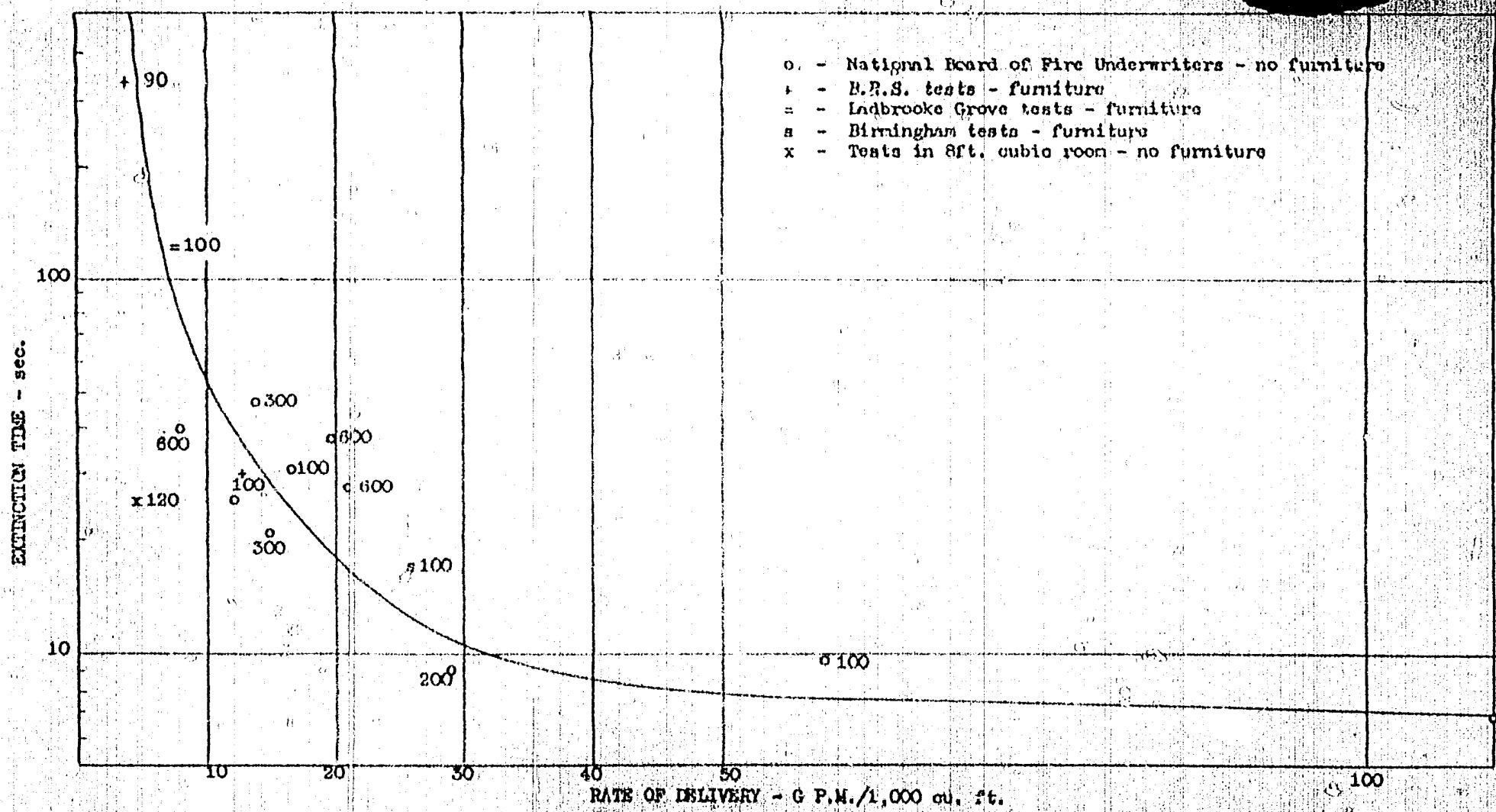


FIG. 1.

THE EFFECT OF DELIVERY RATE ON EXTINCTION TIMES AT VARIOUS NOZZLE PRESSURES.

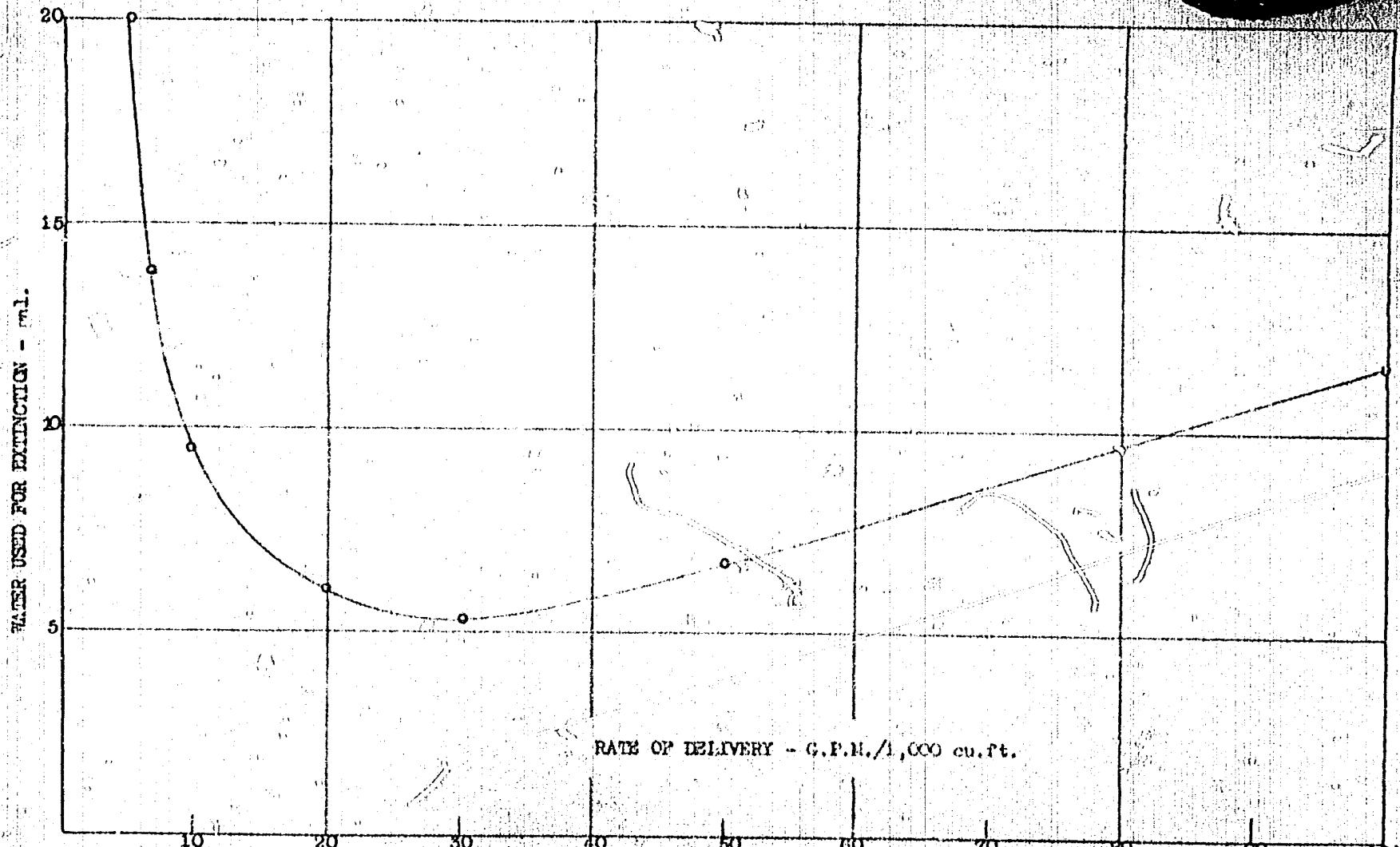


FIG. 2.

QUANTITY OF WATER REQUIRED FOR EXTINCTION AT VARIOUS RATES OF DELIVERY.

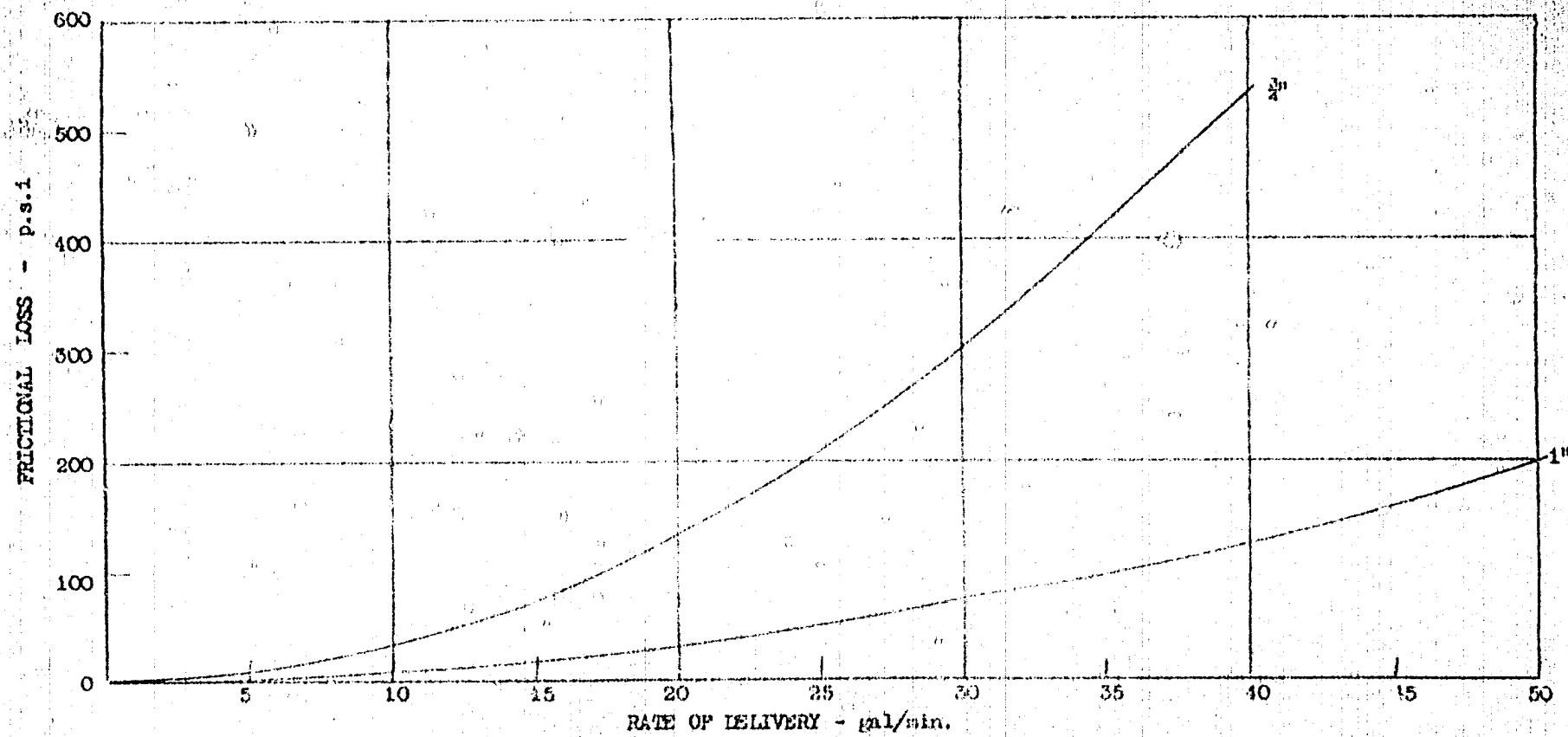
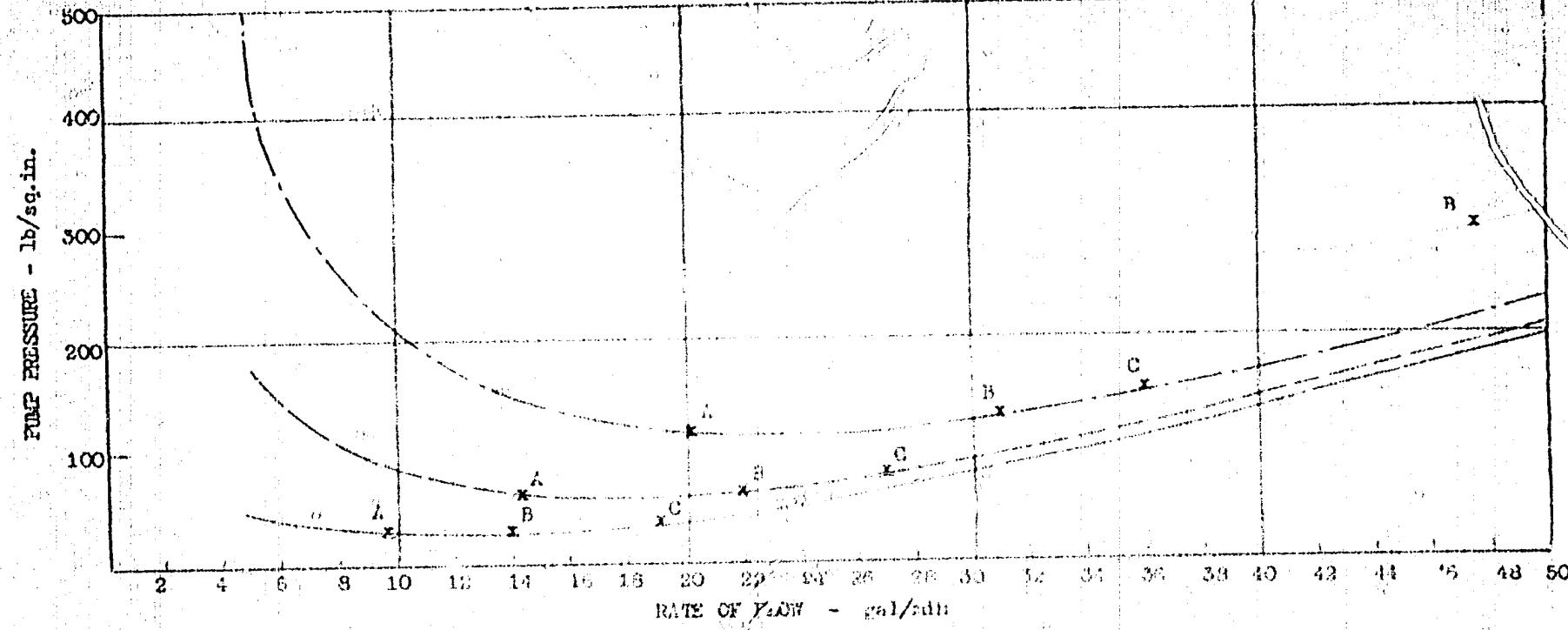


FIG. 3.

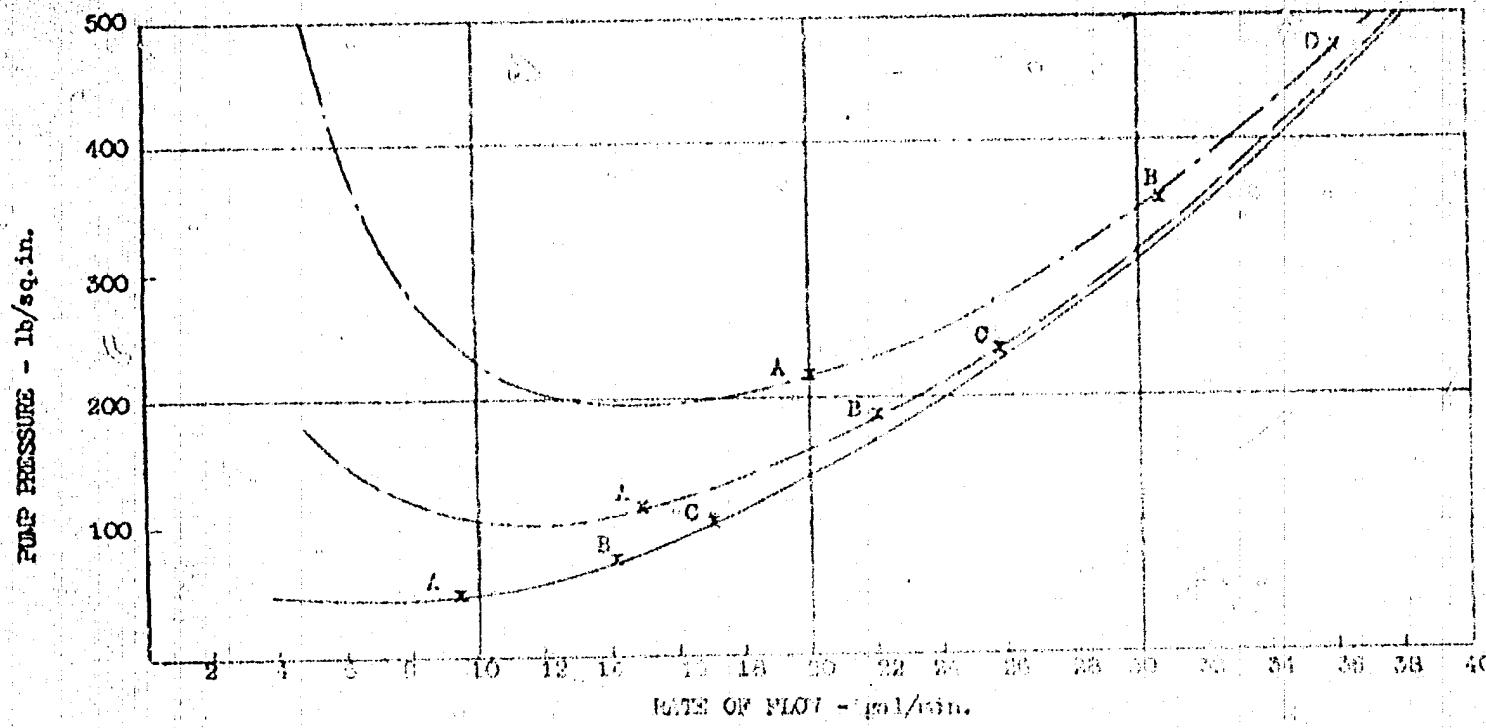
FRictional LOSSES IN 240 FT. OF $\frac{3}{4}$ " AND 1" HOSE AT VARIOUS RATES OF FLOW.



The points A, B, and C on the curves respectively, indicate 5/16", 7/16" and 1/2" minimum nozzle diameters required.

FIG. 5.

PUMP PRESSURE REQUIRED TO PRODUCE VARIOUS RATES OF FLOW FOR DIFFERENT THROWS, CORE ANGLES, AND NOZZLE DIAMETERS, THROUGH 240 FEET OF 1" BORE RUBBER LINED HOSE.



The points A, B, and C on the curves respectively, indicate 5/16", 7/16" and 1/2" minimum nozzle diameters required.

FIG. 4.

PUMP PRESSURE REQUIRED TO PRODUCE VARIOUS RATES OF FLOW FOR DIFFERENT THROTS, CONE ANGLES, AND NOZZLE DIAMETERS THROUGH 240 FEET OF $\frac{3}{4}$ " BORE RUBBER LINED HOSE.

$$T = 10^\circ \alpha = 30^\circ$$

$$T = 30^\circ \alpha = 5^\circ$$

$$T = 20^\circ \alpha = 60^\circ$$

$$T = 20^\circ \alpha = 30^\circ$$

$$T = 10^\circ \alpha = 60^\circ$$