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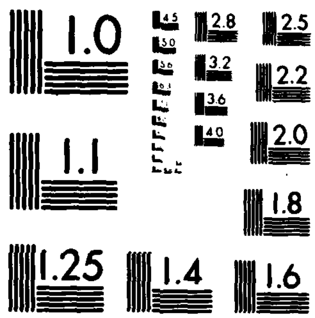

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Mechanical Engineering Technical Memorandum 400

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Approved for Public Release.

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SUMMARY

This report describes the design and operation of a variable exposure cloud drop sampling device, as used during Nomad anti-icing trials in Australia and in the United Kingdom.

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16\. ABSTRACT:

This report describes the design and operation of a variable exposure cloud drop sampling device, as used during Nomad anti-icing trials in Australia and in the United Kingdom.

CONTENTS

1. INTRODUCTION

The 1978-79 series of anti-icing trials for Nomad aircraft (Atkins, 1980) required measurements of the drop size distribution, volumetric mean diameters* and liquid water content of water clouds reaching the aircraft. The drop size data were required in ground based icing tunnel tests, in flight trials using a tanker aircraft with a boom sprayer and in further flight trials in natural icing conditions conducted in the United Kingdom.

In an earlier Nomad icing investigation (Smedley and Dick, 1975), a drop sampler based on a magnesia coated target rod (Doogood, 1961) was used. This device was considered unsuitable for the present tests (see Skidmore and Pavia, 1979) so a technique employed by CSIRO Division of Cloud Physics was adopted. This technique uses a narrow glass slide coated with a thin layer of soot from a kerosene flame. Water drops, on impact with the soot coating, cause a circular splash mark or impression to be formed; the relation between the sizes of impression and drop has been measured (Squire 1958). CSIRO had developed an automated, multiple exposure cloud sampling device using the above technique. This instrument was not available and was moreover considered too heavy and complex for extended use in the air-borne cloud sampling trials. A simpler, rapid-loading, single exposure sampler was designed and built at ARL and subsequently used in the anti-icing trials.

This memorandum describes the device and its operation.

2. DESIRABLE FEATURES OF A DROP SAMPLER

2.1 Stationary Target

To avoid comet like impressions and streaks on the target surface, a stationary target is desirable. Initial tests at ARL found this an especially critical requirement with soot coated slides.

2.2 Variable Exposure Times

Correct exposure of the surface of the target is essential. Over exposure of the target will result in multiple overlapping of impressions while under exposure will result in a sample that cannot be

* The volumetric mean diameter is defined as that diameter at which 50% of the volume of the spray is contained in drops above that diameter.

considered representative of the drop population. Experience with soot coated targets showed that exposure leading to an impression coverage of 5-10% of the target surface proved satisfactory. The coverage can be optimised for all operating conditions by varying the exposure time.

Pavia et al. (1980) describe accurate electronic methods for determining liquid water content. However, an approximate liquid water content for checking purposes can be computed from the drop count and aircraft speed if the exposure time of the drop sampler is known.

2.3 Ease of Loading

The device should either incorporate a magazine of targets or facilitate quick and easy change of targets without damaging the coated surface.

2.4 Compact Size

To enable use within the confines of a cabin, a small lightweight construction is desirable.

2.5 Operability with Gloves

As cabin temperatures can drop below zero, operation of the device must be possible while wearing protective gloves. This applies also to handling and storage of exposed targets.

3. DESCRIPTION OF SAMPLER

3.1 General Description

The drop sampler was designed to accept target slides of the type used by CSIRO in their automated cloud sampler (see Fig. 1); it comprises a stationary slide holder accepting a single target which is covered by a rotating shutter. A torsion spring, coupled to the shutter, provides the necessary force to rotate the shutter when the trigger is depressed. A photograph of the device is shown in Fig. 2a with a close up view of the shutter and target assembly shown in Fig. 2b.

3.2 Detailed Description

3.2.1 The shutter

The shutter shown in Fig. 3 covers the target surface with the shield (A). It is prevented from rotating by a pin located in the slot (B). When the trigger is operated the pin is withdrawn from the slot allowing the shutter to rotate. After rotating approximately 270^{o}, thus exposing and then recovering the target, the shutter is stopped by the stop (C) striking the pin.

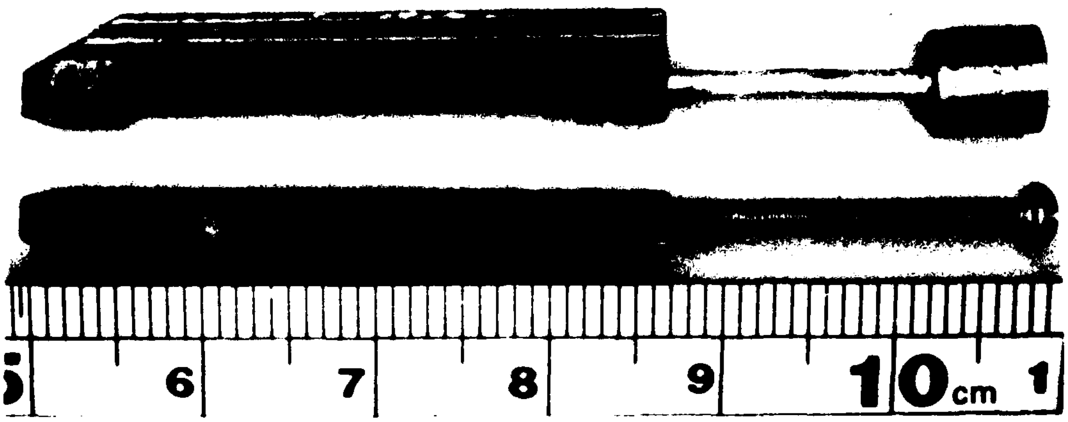

FIG. 1 CSIRO TYPE TARGET

(Note: extensions to improve handling)

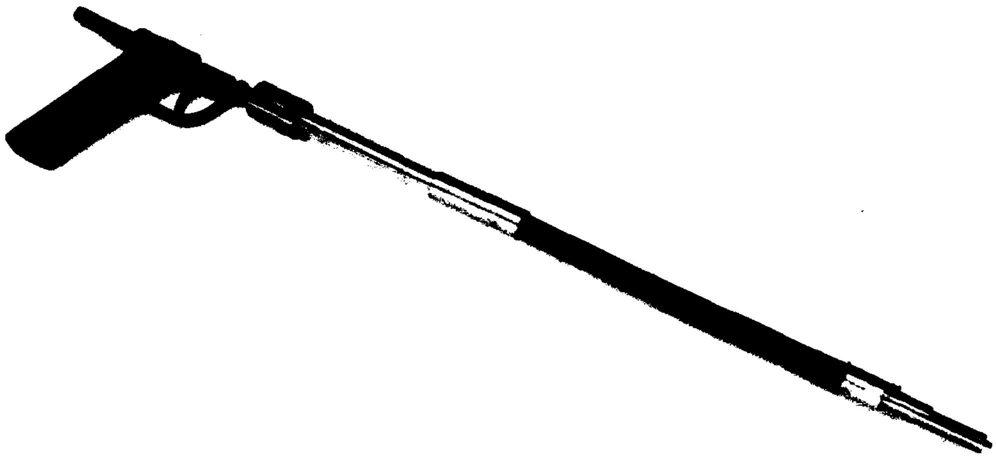

FIG. 2(a) DROP SAMPLING DEVICE – GENERAL VIEW

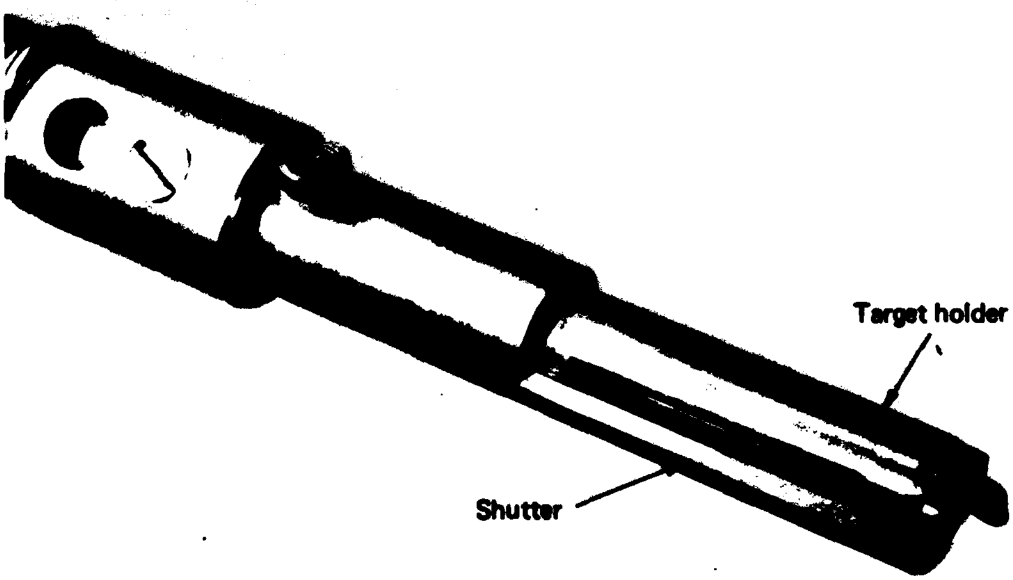

FIG. 2(b) CLOSE-UP VIEW OF SHUTTER – TARGET HOLDER ASSEMBLY

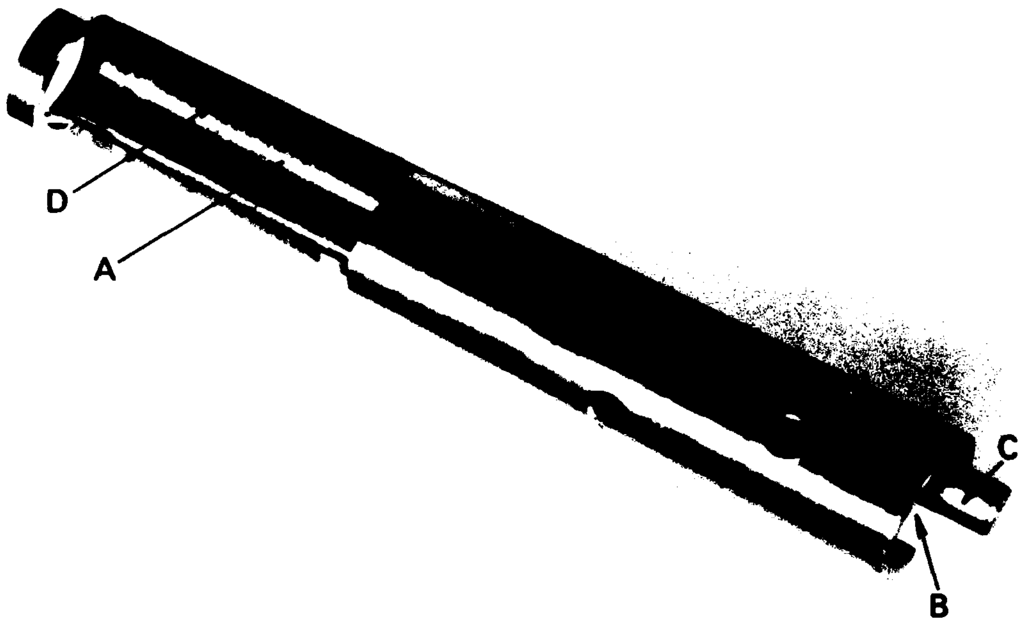

FIG. 3 SHUTTER

The inner leading edge (D) of the shield is relieved by an angle of 15^{o} from the radial; the trailing edge is square. High speed films of the shutter in operation show that water adhering to the shield is shed away from the target with the onset of rotation. These films further provided a calibration of shutter speeds; times varied from 0.010 to 0.080 seconds according to spring tension.

3.2.2 The target holder

The target holder, shown in Fig. 4, was designed to accept the glass-on-metal targets of the CSIRO type shown in Fig. 1. A small compression spring is located at the bottom of the hole (A) to eject the slides when the retaining clip (B) is released. The groove (C) accepts a screw from the shutter allowing it to rotate but preventing axial movement.

3.2.3 Spring and tensioner

The torsion spring (Fig. 5) is made from 1.6 mm stainless steel wire, attached to the shutter via the bush (A). Spring torsional force is increased by rotating the tensioner (B) and locking with a set screw. The slot (C) in the tensioner allows axial movement of the spring as it is rotated.

4. OPERATION

A previously coated target is inserted into the gun. The shutter is rotated about 270^{o}, against the spring torsion, to cock the gun. Once cocked the shutter end of the device is inserted into the spray or cloud and fired, making sure that the slide surface is normal to the flow. After exposure the device is withdrawn and the target removed by releasing the retaining clip. In practice this takes about 5 to 10 seconds.

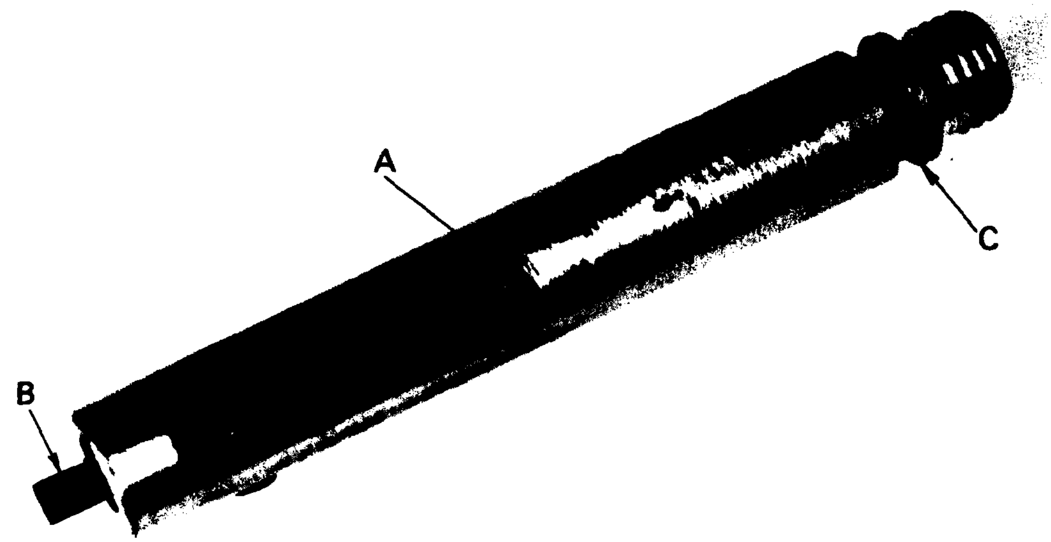

FIG. 4 TARGET HOLDER

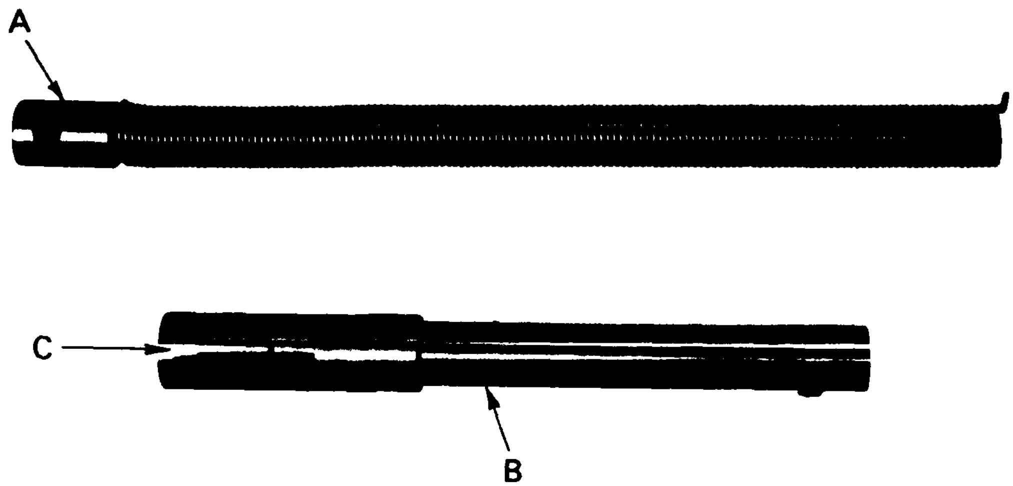

FIG. 5 SPRING AND TENSIONER

5. DISCUSSION

Ground based tests showed that targets coated with soot and gelatine worked equally well in the device. It is most likely that targets coated with magnesium oxide would also be satisfactory. Oil wetted targets, which use transmitted light illumination for microscopic examination, were not successful as the glass strips had to be removed from the metal backs for examination.

6. CONCLUSION

A drop sampler has been designed, built and subsequently used with good results for sampling clouds and sprays. Using the CSIRO type targets useful impressions were obtained using both soot and gelatine coated targets.

REFERENCES

Atkins, P.B. (1980). To be published, ARL Mech. Eng. Report. (Title will be available soon).

Doogood, P.N. (1961). Progress in the Development of a Droplet Sampling Device for Use at High Temperatures. ARL Mech. Eng. Note ME.244.

Pavia, R.E., Repacholi, N., Skidmore, F.W. and Adams, M., (1980). Comparative Tests of Two Liquid Water Content Meters as used on Nomad 1978-1979 Anti-Icing Trials. To be published. ARL Mech. Eng. Report.

Skidmore, F.W., and Pavia, R.E., (1979). Techniques for Examining Drop Size Spectra in Water Sprays and Clouds. ARL Mech. Eng. Note 375. (In Publication).

Smedley, M.A. and Dick, F.M. (1975). Nomad N2, N22 and N24 Test Certification. GAF Report No. N2-11072, Engine Inlet Anti-Icing, Issue 1.

Squires, P. (1958). The Spacial Variation of Liquid Water and Droplet Concentration in Cummuli. Tellus 10, 372-380.

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