MAKING SMOKE

BY

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The Problem

If you've got to make smoke there are a number of ways to do it. The simplest perhaps is wet weeds on a bonfire. Steam ' plumbers ' do it by not running their fans fast enough or something. In some ships there is even a little valve just beneath the boiler steam drum labelled ' Make Smoke '. What it does is a bit of a mystery as it's usually been seized solid for years. However, our problem was slightly different.

For the first time ever, the Society of British Aircraft Constructors invited the Fleet Air Arm to take part in their 1957 show at Farnborough. Broken down, this meant that 738 Squadron from Lossiemouth were told to put on a seven-minute display of aerobatics.

Aerobatics under these circumstances have to be good and to be successful in this modern age it is necessary to have a ' gimmick ' or two. The R.A.F. team taking part in 1956, 111 Squadron, had their Hunters painted a glossy black which was an improvement on their normal rather bilious camouflage. Not to be outdone, 738 Squadron's Seahawks were painted pillar box red, but that small piece of ' one upmanship ' was not considered enough, and the order went forth ' Make Smoke '.

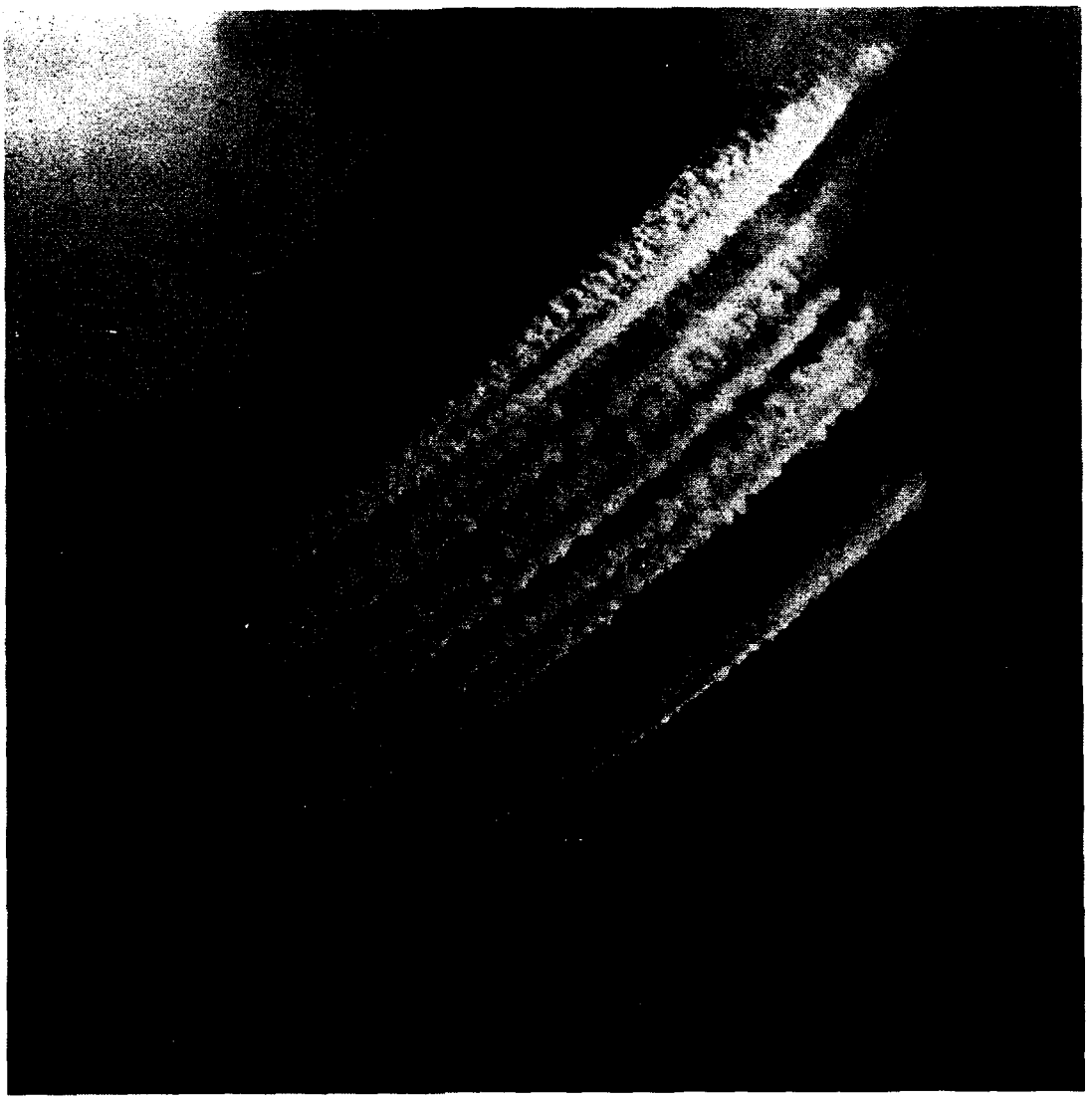

FIG. 1—MAKING SMOKE (by courtesy of *Flight*)

In the past, aerobatic teams laying smoke trails have used R.A.E. smoke generators. This is nothing more than an electrically fired smoke float, and has the disadvantage that once it has been started nothing will stop it. In fact, 111 Squadron used them last year and for those of you who saw the show (either ' live ' or on television) you will have noticed they only used it for the last part of their show. Thus the unspectacular and intermittent shutting off was not seen by the public.

Requirements

The requirements for the ' Lossie ' smoke device were :—

(i) Simple on-off selection under the Pilot's control
(ii) Five minutes' endurance
(iii) A dense persistent smoke trail to be laid by a Seahawk aircraft at all speeds and altitudes, preferably coloured
(iv) Easy manufacture and installation
(v) Installation not to affect flying characteristics

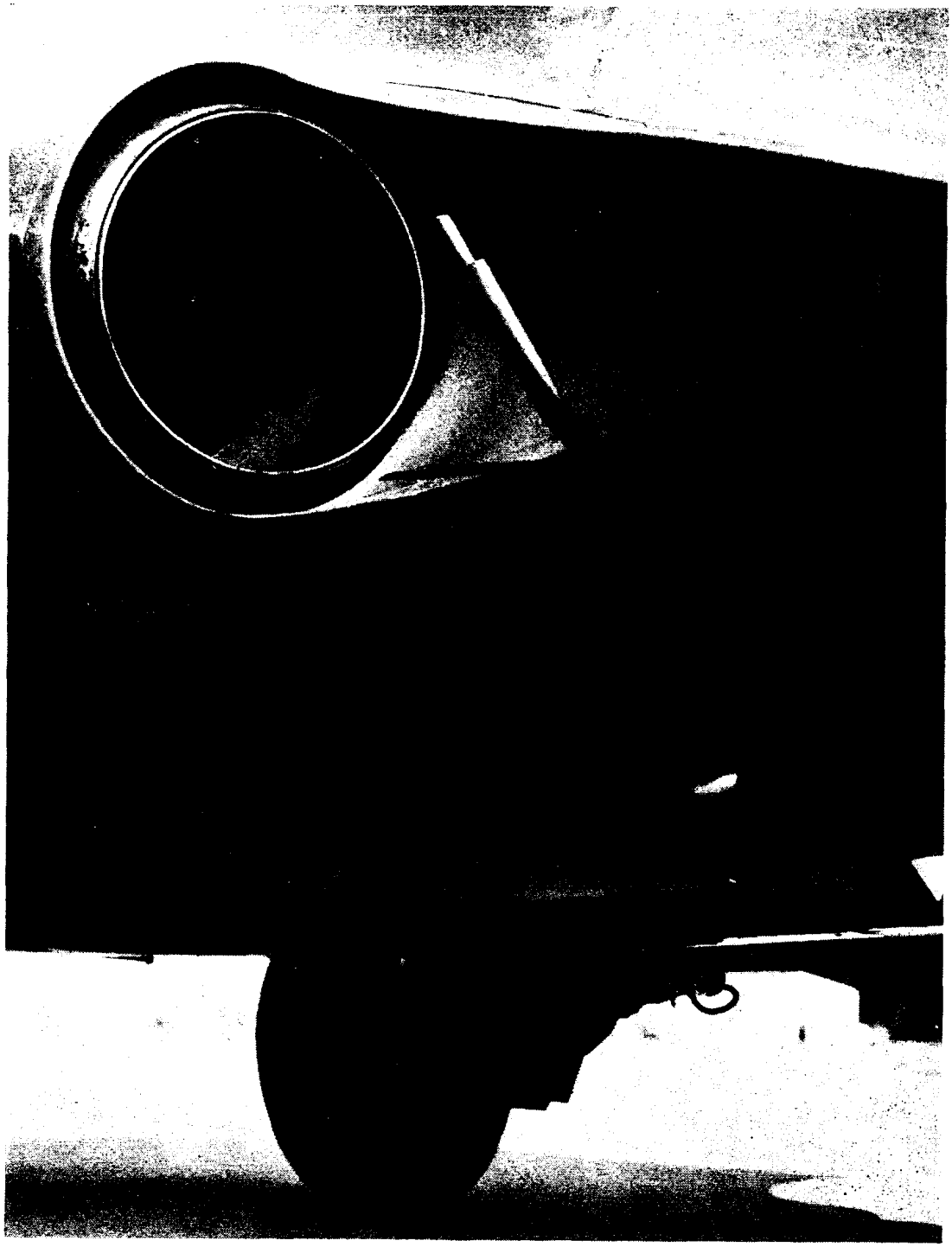

FIG. 2—THE FINAL INSTALLATION

(vi) No fire risk

(vii) Cheap

(viii) Finally, after the show, the whole device to be removed and the aircraft put back to its normal state.

A certain amount of initial design work was carried out on the back of bar chits and it was immediately obvious that we had little background knowledge to call upon.

Design Consideration

The first problem was what fluid to use and how much would be required.

Commander (E) bravely approached a Seahawk jet stream carrying a garden syringe full of Nene Engine Oil (OM 13). A few squirts produced lots of lovely white smoke, but also rather horrified us by the amount of oil required. It appeared that something of the order of twenty gallons would be consumed in five minutes, and the next problem was, where to carry it. Any form of external tankage was ruled out and it was decided to use one of the aircraft's fuel tanks. The Seahawk has three internal fuel tanks, for'd (185 gals), saddle (42 gals) and rear (170 gals). As the pilots like to have the two large tanks to propel the aircraft, the saddle tank was the obvious choice. This is reasonably adjacent to the jet pipes, has adequate capacity and is pressurized to 5 lb/sq in.

This last fact was important as the problem of transferring the oil from tank to outlet had now to be considered. We hadn't got a suitable pump and didn't want to use one. Bernoulli's Theorem was extracted from some old Keyham notes, dusted, and showed that with this pressure and using $\frac{1}{2}$ in. delivery pipes a supply of over six gallons per minute might be forthcoming. This, of course, allowed for no friction losses in the pipe, but even assuming 50 per cent loss, three gallons/minute was estimated to be adequate.

Production commenced and consisted of :—

(*a*) Replacing the fuel pipe connecting the saddle to rear tank with a new pipe which stuck out through the bottom of the fuselage

(*b*) Blanking off the disturbed fuel lines

(*c*) Connecting a mechanically operated valve to the end of the fuel pipe

(*d*) Leading a $\frac{1}{2}$ in. tungum pipe from the valve to the centre of the starboard jet pipe orifice.

The time came for the first trial. The aircraft was pushed out, numerous fire extinguishers manned, the engine started and we were off. An A.A.3, equipped with a fearnought suit and running shoes, crept under the wing and gently pushed a piece of wire to open the valve. A pause—success—and clouds of beautiful thick white smoke. A flock of seagulls took one look and headed out to sea.

Control

The next problem was to give the pilot control of the smoke as it was considered impracticable to strap the A.A.3 to the bottom of the aircraft, or to replace his running shoes by wings. Consequently, the mechanically operated valve was replaced by an electrically operated Saunders cock as used in the Seahawk cabin pressure system. The ' L Boys ' were called in and by utilizing existing but not essential cable runs (e.g. gun firing, navigation lights, etc.) provided control from the gun firing button.

They had a bit of fun as the cock had a split field shunt-wound motor, whatever that might be, and, to start with, when they switched on they couldn't switch off and vice versa, but with a little jiggery-pokery and by utilizing the second button (R/P.s) on the control column, on-off selection was obtained.

On the plumbing side, the tungum pipe was replaced by two stainless steel pipes feeding to both jet pipe orifices, tungum tending to wilt in the heat. A fairing was made to streamline the bits which stuck out of the bottom and we were ready for the first flight trial.

Flight Trial

The Commanding Officer of 738 Squadron was the guinea pig driver and got airborne, accompanied by a Vampire to see what happened. Twenty minutes later he returned over the airfield leaving a trail of nice thick persistent smoke. Having carried out a loop and then gone back to look at it he landed and pronounced himself satisfied. At lunchtime that day the bar chits were used for their normal purpose.

During the flight trials, consumption was found to be $3\frac{3}{4}$ gallons per minute which meant that we were getting a 40 per cent friction loss in our pipe system ; we did nothing about it on the reasoning that the system worked and we didn't want to play about with it.

The prototype installation was sent to Fleetlands, and they embodied the modification in the remaining aircraft required for the display. For those of you who were lucky enough to get tickets for Farnborough you've seen the result. For the unlucky, the team also took part in the Air Days at Lee-on-Solent, R.A.F. Valley, R.A.F. Syerston and Abbotsinch.

Going back to our original requirements, we never found a suitable substance to colour the smoke and the system would not work under prolonged negative ' g ', but we coped with the rest—except, of course, fire risk. We think we've invented a new secret weapon.

SIGNAL

From: Admiralty Dtg.....Z/August

To: N.A.S., Lossiemouth.

Your SO and SO Modification is approved.

Smoke trail is inflammable and aircraft are not (R) not to be flown through it.

Stop Press

The R.A.F. have since asked us how we did it so that they can use it for this year.

Any ideas for bigger and better ' gimmicks ' for 1958 will be gratefully received at Lossiemouth.