TRANSONIC TUNNELS . . .

First of the afternoon papers was *Some Aspects of Transonic Tunnel Operation in Industry*, by Mr. F. E. Roe, B.Sc.(Eng.), D.I.C., of English Electric. Early in 1950, Mr. Roe said, the original jet-driven tunnel of his company was converted to transonic operation. The working section was reduced to one square foot, surrounded by a 3ft × 2ft plenum chamber, and various slotted and perforated walls were tested. More success was achieved with slotted walls, and these were used for a year for model testing before further experiments with detailed modifications resulted in a maximum Mach Number of 1.22 and an improved Mach-number distribution.

Interference effects were first noted in tests on a scale pitot-static head, and a limited series of tests were then undertaken on a number of simple bodies of revolution. These tests revealed that the flow pattern around the bodies could be modified by the slotted walls, and that the interference effects increased with model size and bluffness. The interference effects were pronounced at both subsonic and supersonic Mach Numbers.

Further data showed that model blockage played an important part in the validity of force data measured on a typical aircraft model. Nevertheless, in spite of the uncertainty of interference effects, sufficient correlation had been obtained between wind-tunnel and flight-test results on the P.1 aircraft to encourage the use of slotted-wall tunnels in the transonic range.

The final paper, presented by Mr. F. O'Hara, M.A., of R.A.E., Bedford, was entitled *Notes on the Assessment of Results Obtained in a Transonic Wind-tunnel*. In it, the speaker stated the need for a comparative assessment of the possible overall errors in force and pressure measurements in relation to desirable standards of accuracy.

Problems of flow uniformity, accuracy of model manufacture, and interference effects were discussed in turn, and details were given of the transonic working section of the 3ft tunnel at R.A.E., Bedford.

After comparing results obtained in the tunnel with those from free-flight model tests, Mr. O'Hara went on to discuss illustrative examples of model results with a number of full-scale flight comparisons. He concluded by commenting on the problem associated with maintaining representative flow conditions on sting-mounted models.

Final Discussion Period

General discussion on the day's topics was opened by Prof. A. R. Collar, chairman of the wind-tunnel design committee of the Aeronautical Research Council. Among his questions were the following: How were contraction sections for transonic tunnels designed? Was the shape of diffusers based on experimental work or largely arbitrary in design? What proportion of the total available power was needed for the auxiliary suction plant? Assuming two ventilated walls and two solid, could blockage interference be eliminated, leaving only shockwave reflection? Was not direct measurement of tunnel speed possible, by spark observation or measurement of sound?

Following Prof. Collar's remarks, Mr. Hills said the A.R.A. contraction shape was a modification of an existing contraction, and that it had been model-tested. The shape near the nozzle was the most important consideration. A shape equivalent to a five-degree cone, later modified to 5½ deg, had been the basis of the diffuser design; it was not thought that model tests could help here because of Reynolds Number effects. Auxiliary power amounted to rather less than half the main-motor power; as the pressure ratio was 3 : 1, the actual power required was high. He did not think more-elaborate methods of speed measurement were needed.

Mr. Vessey thought that two ventilated walls would be sufficient to avoid blockage. For ordinary model tests, plenum-chamber pressure would be used for speed measurement for some time yet. If one had a normal contraction and not a supersonic nozzle, about half the fan power would be needed in auxiliary suction. Mr. Kirk agreed that more design work could be carried out on contraction sections. Mr. Roe, speaking of speed measurement, said that his company had tried pressure measurements on the tunnel wall (at the point where the flow stabilized) and in the plenum chamber. If the model affected the plenum-chamber pressure, he claimed, the plenum-chamber pressure affected the model, and results were therefore questionable.

Another speaker suggested that the length of working sections should be at least four times their height. From experimental evidence, the pressure of two plain walls in a ventilated working section seemed to affect the pressures on the model very little. Was the testing of half-models a valuable technique? The main speakers said they did intend to continue half-model testing; Mr. O'Hara called attention to the effect of leaks around the wall-root, and the effect of low aspect ratios.

The power requirement expressed in relation to working-section area, the subject of another question, was stated by Mr. Hills to be about 430 h.p. per sq ft at $M = 1.4$, for the A.R.A. tunnel, and (by Mr. Vessey) about 400 h.p. per sq ft at $M = 1.2$ to 1.3 for the R.A.E. 8ft × 6ft tunnel. Dr. Hilton's estimate for the Armstrong Whitworth tunnel was about 2,000 h.p. per sq ft, however. "There is quite a discrepancy here," he commented. But pressure ratio, not power, was the important factor.

Work at the College of Aeronautics on the use of vortex strips ahead of half-models to reduce boundary-layer effects was mentioned by another speaker, who submitted that the tricky calculation was to determine the appropriate model size for a given working section. What Reynolds Number had been aimed at in the design of the A.R.A. tunnel?

Mr. Hills replied that a Reynolds Number of about 45×10^6, based on wing chord, had been the objective, but this figure did depend on the type of model used. Mr. Vessey said that the Cranfield method of "sweeping away" the boundary layer had been followed up at R.A.E., Bedford, with interesting results. It appeared a useful device for low-speed tests.

Other questions referred to the possibility of employing struts for model-mounting in addition to stings; the problem of the re-entry of the air from the plenum chamber into the tunnel; and the permissible blockage percentage if a limited range of tests were acceptable. The day's discussions had provided a useful insight into transonic testing problems—limited only by the "security" considerations mentioned so often during the day by the chairman of the meeting. The full publication of the main papers in the Royal Aeronautical Society *Journal* will record many aspects of these problems in this country. What is immediately obvious is that there is a large amount still to be learned.

REMAINING RARITIES (continued from page 8)

them could be resurrected to flying standard in the unfortunate event of LF363 coming to untimely grief.

The Spitfire is in a slightly happier position, and a few continue to render their daily services—though for how much longer one prefers not to think.* Everyone knows of the specimen stationed at Duxford and used each year to share the lead of the Battle of Britain fly-past with the lone Hurricane; but how many people realize that four or five Spitfire L.F.16s purr round the London area on Army co-operation work from Hornchurch, or that a similar number of P.R. 19s is based at Woodvale, in Lancashire, and that each morning one climbs to about 40,000ft to obtain high-level met. information? These last few remaining 19s were drawn from the ranks of No. 541 Squadron, the last regular unit in this country to operate Spitfires and which gave way to the modernity of Meteor P.R. 10s only in 1951-2, when it left its base at Benson and moved east to form a part of B.A.F.O.

Apart from those Spitfires flying in the Service, a Griffon-powered Mk 14, G-ALGT, still operates as an engine test-bed for Rolls-Royce at Hucknall, while a Mk 5b, once on the civil register as G-AISU and formerly flown by G/C. (now A. Cdre.) A. H. Wheeler, is preserved by its manufacturers and flies today (albeit occasionally) in the military markings of its time and with the serial AB510. On the other hand, G-AIDN, the prototype Spitfire T.8, made its last flight last July, when V. H. Bellamy collected it on a ferry permit to place it in its permanent resting-place with the Hampshire Aeroplane Club at Eastleigh.

Lastly, we have the Tiger Moth. Although dozens are flying with clubs and a few are privately owned, the type was officially declared obsolete by the R.A.F. just over two years ago. The Royal Navy, however, are not always in such haste to dispose of their better aeroplanes; in addition to preserving a Swordfish and Seafire 14 they have just purchased four Tiger Moths from civil sources to use for glider towing and for giving air experience to cadets and midshipmen. Two of these Tiger Moths, with the ultra-modern serials XL714 and XL715, were delivered recently after overhaul by Hants and Sussex Aviation at Portsmouth.

Several other military-type aeroplanes are maintained by their makers, among them Hawker's veteran Hart G-ABMR, Fairey's Fulmar G-AIBE (the original prototype), Gloster's Gladiator G-AMRK, and a few others. While it is to be hoped that these may last for many more years one cannot have the same confidence in the future of those machines still in Service hands; but presumably we are wasting our time in reminding the Air Ministry that time marches on and that only action *now* can give us a Lancaster, Mosquito, Beaufighter, Hurricane and Spitfire for permanent preservation.

**No longer; since this paragraph was written the Air Ministry has announced the withdrawal of the remaining regularly active Spitfires (see page 30).—Ed.*