separation and by the wake. Finally, there are the acoustic disturbances which arise from the fact that the aircraft, through the medium of its engines, is a source of noise. Simple estimates show that the enhancement of the noise of the aircraft in a typical case falls very far short of the intensity of the pressure disturbance associated with the bang (about 1 lb./ft.^{2}). Equally, although it is more difficult to show, it is not expected that the enhancement of the disturbances due to turbulence could be sufficient to explain the intensity of the bangs. On the other hand, calculations have been made of the disturbances to be expected from flight through an inviscid fluid, and these yield pressure disturbances that are of the same order as those that have been experienced.

Thus far we have explained the occurrence of the bangs, and the intensity of the peak pressure disturbance to be expected. What still needs clarification is the acoustic 'character' of the bang. In particular, do the disturbances due to engine noise and due to turbulence make a significant contribution to what one actually hears ?

I am indebted to the Chief Scientist, Ministry of Supply, for permission to publish this communication, but the views expressed are my own.

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[1] *Nature*, **170**, 808 (1952).

The impression exists that the double bang made by supersonic flight is mysterious. It would be well if those who support this view would bring forward the arguments that show that the exact and straightforward account of the bangs given by T. Gold[1] is wrong. The following circumstances have made the subject seem mysterious; but, in fact, none of them is a real objection to the straightforward account.

(*a*) At the recent Farnborough display, the black *D.H.* 110 aircraft gave a triple bang on at least one occasion. But we should in general expect multiple bangs if an aircraft were to change course slightly in its supersonic flight, for then there would be two solutions of the equation $-dr/dt = c$, for each straight portion of the aircraft's path, where r is the scalar distance between aircraft and observer. When three bangs are heard, it is likely that there are really four, of which two happen to coincide. It must be remembered that these bangs are so close as scarcely to be heard separately.

(*b*) The bangs are often said to be produced as the aircraft 'pierces the sound barrier' at either end of its supersonic flight. This is inconsistent with Gold's account, according to which at every given supersonic speed there is a direction making a definite angle with the direction of flight along which the bang will be propagated. Now the first account cannot be correct, because it means that the very loud bang heard at all points on the ground will have been produced at one point in the track of the aircraft. Such a dissipation of energy would be of an altogether greater order of magnitude than that at other points, and the aircraft could not accelerate to greater speeds.

(*c*) The objection that shock waves and sound waves are different in nature is not relevant to this discussion, because we need consider only regions outside a certain closed surface surrounding the aircraft, at all points of which the particle displacement due to sound or shock waves is small compared with their wave-length. Yet this closed surface can be effectively at a point as far as listeners on the ground are concerned.

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[1] *Nature*, **170**, 808 (1952).

The acoustic phenomena accompanying the dive of an aircraft to attain supersonic speed appear to be adequately explained by the Huyghens wavelet construction. The case of a body moving at a uniform supersonic speed V in a straight path, in a uniform atmosphere, is well known. Circular wavelets, expanding with the velocity of sound c, are centred on successive positions of the body at chosen time intervals. The envelope of the wavelets representing a shock wave front is a cone with the line of flight as axis and half-angle α given by

$$\sin \alpha = c/V = 1/M,$$

where M is the Mach number.

In the case of a body moving in a uniform atmosphere, in a straight path, at a speed which increases and then decreases through the speed of sound, the shock wave departs radically from the single conical surface and becomes a meniscus symmetrical about the line of flight, with two surfaces. In the example shown in Fig. 1, the duration of supersonic flight is 16 sec. and the Mach numbers are shown at the positions of the body at second intervals.

In the case of a body moving in a uniform atmosphere, at a uniform speed, in a curved path, the shock wave becomes a distorted meniscus. The section in the plane of the flight path is similar in general outline to that shown in Fig. 2.

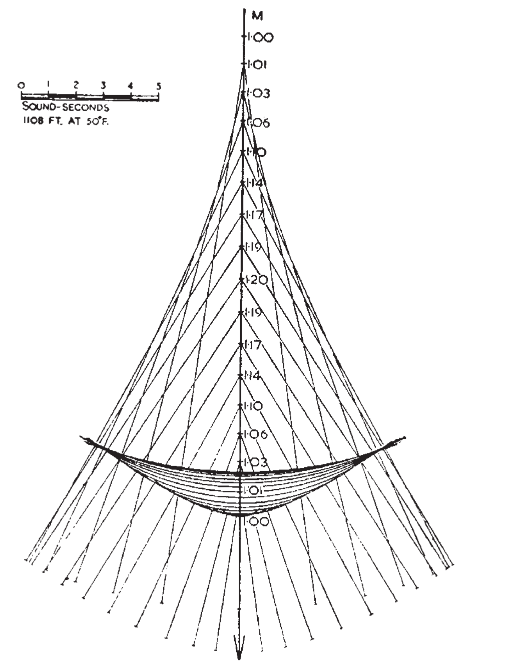

Fig. 1. Shock wave formed by a body moving in a straight line at a speed which increases and then decreases through the speed of sound