A NEW BREAK IN THE SOUND BARRIER

Young engineer's discovery is the greatest advance in aviation since the beginning of the jet age

Flying together over the California desert one day last week were two Delta-wing jet fighters (above), both called F-102 and both powered by the J-57 engine. One looks straight and trim, the other oddly pinched in the middle. One has a short nose, the other a long one. But their differences are not mere differences of shape. The F-102 at left, though planned to go faster than sound, cannot. The F-102A at right can, and with a top speed of more than 900 mph is fast becoming a mainstay of U.S. air defense. How it got that way is the story of the greatest advance in aviation since man first broke the sound barrier.

That advance, a discovery only recently disclosed, is called the Area Rule which, in effect, puts an airplane's bumps and indentations in the right places. Its effect is to change the shapes of planes like the F-102 and push them smoothly through the sound barrier, the dangerous wall of shock waves which jets ordinarily cannot penetrate without great bursts of extra power. How it works is described on the next page.

Area Rule literally saved the F-102. After turning out what they were convinced would be a supersonic fighter, Convair designers discovered it would not even reach the speed of sound. Gambling on the then unproved theory of Richard Whitcomb, 34-year-old engineer of the National Advisory Committee for Aeronautics, the designers reworked the F-102 to give it a pinched waist, longer nose and a bulged tail. On its first try the new F-102A slipped smoothly into supersonic speed while still climbing.

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IN OLD F-102, heavy shock waves build up ahead, in center and at rear as air (arrows) is shoved roughly aside to make way for nose, body and wings.

HOW NEW DESIGN RULE WORKS

When an airplane approaches the speed of sound (760 mph at sea level) it begins moving so fast that the air around it cannot get smoothly out of the way. The air, therefore, is shoved violently aside and heavy shock waves of compressed air build up. One shock wave bunches ahead of the plane where air is pushed aside to make way for the nose. A second builds up as the widening fuselage and wings begin pushing more air out of the way. A third shock wave shoots out near the trailing edge of the wing. The plane must carry these waves along with it through the transonic zone, the speed range between 600 and 800 mph, and this constitutes an enormous drag on the plane.

NACA Engineer Richard Whitcomb (next page) logically concluded that if the air could be less violently displaced, the waves and the drag would diminish, enabling the plane to pass more easily through the transonic zone. Whitcomb's solution (below) applied his Area Rule to taper and lengthen the nose of the F-102 so that air would move aside more gradually, and to pinch the waist so that air which otherwise would be sharply brushed aside would have a place to go. The result: although the same amount of air must get out of the way to make
IN NEW F-102A, shock waves still form but are drastically reduced, largely by pinched waist which allows smoother air flow around wings and body.
AERONAUTICAL INNOVATOR Richard Whitcomb crouches in wind tunnel with supersonic plane model whose pinched waist, long nose, obey Area Rule.

HOW THE BREAKTHROUGH CAME FROM TINKERING WITH TOYS

Working as an engineer at the National Advisory Committee for Aeronautics laboratory at Langley Air Force Base, Richard Travis Whitcomb in 1951 found the answer to a question which had baffled jet designers: why their supersonic planes hardly ever flew as fast as they were supposed to. The reason, Whitcomb found, was because they were wrong in predicting the total drag on a plane. They arrived at the figure simply by adding up the drags on the plane’s parts, like wings, engine nacelles and fuselage. After months of shock wave tests in the laboratory’s new transonic wind tunnel, Whitcomb found that the drag on any part differs, depending mainly on where it is located and what other parts are near it. It is this relationship which must be computed in any determination of a plane’s total drag.

Whitcomb incorporated his ideas into an ideal shape for a supersonic plane. When he compared it to existing planes, like the F-102, he saw why they had drag trouble. They violated what he called the Area Rule. The basis of Area Rule concerns the areas of cross sections
Area rule: The size of the wings and body of the plane. If these areas have the proper relationship to each other, they will obey the rule and the resulting design will have a minimum of drag. Whitcomb took models of actual planes and redesigned them, giving wasp-waisted fuselages to some, putting bulges in others. The drag was reduced in some cases as much as 25%.

Whitcomb's views were coolly received at first by the aviation companies. But when the F-102 in actual flight stuck at the precise point in the transonic zone that Whitcomb had predicted, Convair engineers...
hastily redesigned it to the shape shown on page 147. The F-102A not only zoomed through the sound barrier but, with its new shape, went more than 100 mph faster than expected.

When the news spread, Grumman engineers reshaped the F-11-F, Chance Vought redesigned the F-8-U, and today every supersonic plane on U.S. drawing boards conforms to Area Rule. Almost overnight Whitcomb became a hero in the aviation world and has won the coveted Collier Trophy, which will be presented to him next month.

Whitcomb has spent most of his young life getting ready for his big discovery. Even when he was 12 he was at work in the cellar of his home in Worcester, Mass., redesigning his rubber-band-powered model airplane to fly better. All through school, while other boys played ball and chased girls, young Whitcomb tinkered away. At Worcester Polytechnic Institute he designed a bomb with a heat-sensitive device in its nose to guide it to the target. Later at Langley he discovered that one of their hush-hush projects was a heat-guided bomb just like his.

For all his interest in planes, Whitcomb never felt any desire to fly. Once a friend took him up in a light plane. When they got back Whitcomb was pale and shaking. But at Langley he quickly made his mark. In 1944, a year after he arrived, he suggested swept-back wings. But the overworked lab shelved the project and the swept-back wing was developed elsewhere. When the world's first transonic wind tunnel was built at Langley, Whitcomb at last had an experimental setup in which he could achieve his breakthrough to Area Rule.

The discovery has brought about a kind of personal breakthrough for Whitcomb. Lately his associates have noticed that the former singleminded scientific recluse has been dressing up in natty gray flannel suits and siring the girls. But his aeronautical intellect is still percolating. His latest notion, a resurrected boyhood dream, is for a vertically rising airplane with no wings and an engine without moving parts. "If I'm successful," he says, "everyone will be able to fly." This may even include Richard Whitcomb.

—Clay Blair Jr.
AIR PRESSURE PATTERNS around a plane model under test are studied by Whitcomb on a manometer, a rack of glass tubes which measure by different levels of liquid within them the varying pressure along the model’s surfaces.