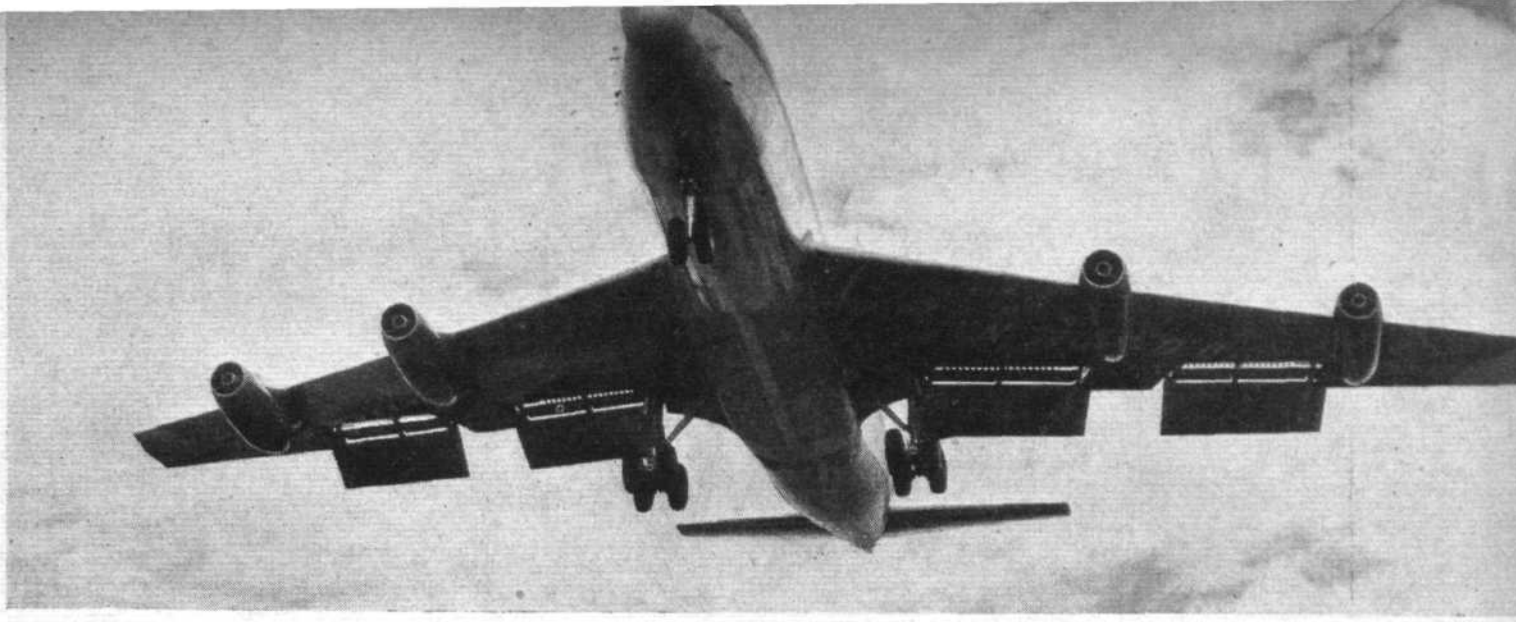

Airliners of the World

BOEING 707

BOEING AIRPLANE COMPANY, SEATTLE, WASHINGTON.

ON a number of counts the Boeing Airplane Company can be considered the largest aircraft firm in the world. Certainly they have unmatched experience in the development of large, long-range, high-altitude, high-speed aircraft, and it is logical that they should build a large jet transport.

With the Boeing 247 of 1932 the company produced the first "modern" transport, with metal skin, a cantilever monoplane wing and retractable undercarriage; yet by 1937 this type of machine was almost monopolized by Douglas and Lockheed. Similarly, the Boeing 307 of 1938 was the first high-altitude pressurized airliner; yet the same competitors obtained the lion's share of the civil market for such machines after World War 2. Now, with the 707, Boeing are the first to offer a really large, long-range jet transport; and, unlike the previous "firsts," this design has already reaped a handsome commercial reward.

Serious thinking of jet transports has been going on at Seattle for a decade. Many hundreds of sizes and configurations have been examined, and the general layout of a 100-ton machine, with four 10,000 lb-thrust engines in separate nacelles carried on a 35-deg swept wing, was reached in October 1949. A year later the first proposals were submitted to operators and by the summer of 1952 Boeing had taken the decision to invest £5.35m of their own money in the construction of a prototype which was to serve both for future airliners and for a jet tanker which Boeing conceived as a replacement for the KC-97 with Strategic Air Command. Manufacture of details began in October 1952 and the machine, designated Model 367-80, flew in July 1954. It has now logged rather more than 500 hours and completed all basic testing.

Boeing were successful in gaining the contract for several hundred tankers, with the designation KC-135. These are now in full production at Renton and the first machine off the line is about to fly.

The KC-135 is a larger and heavier machine than is the -80 prototype, and the airliner has grown correspondingly. For domestic operations the basic machine is the 707-120, powered by Pratt and Whitney JT3C-4s of 12,500 lb thrust. The 707-220 is a basically similar airframe matched to the increased thrust of the Pratt and Whitney JT4A, Rolls-Royce Conway or Bristol Olympus, and designed to cruise at up to 608 m.p.h. Finally, the basically redesigned 707-320 Intercontinental is dimensionally larger and substantially heavier, although it is designed for the same power as is the 220. It is at present largely a paper aeroplane only, although several firm orders have been placed for it. Boeing are also offering a variant of the 707-326 to M.A.T.S., at a gross weight of up to 310,000 lb, landing limit of 210,000 lb and empty weight of 122,000 lb (cargo) or 130,000 lb (passenger); engines would be J75s (military JT4A) and cargo capacity 60,000 lb. Except where otherwise stated, the following refers solely to the 707-120.

AIRFRAME. Essentially, the Boeing 707 is a completely traditional structure formed into a modern shape. Stress levels are conservative and there is practically no integrally stiffened skin, spot-welding, titanium or bonding. Boeing precepts of fail-safe design have already been described at length (for example in our issue of February 11, 1953) and render catastrophic tearing virtually impossible.

Fuselage. The fuselage is built in four sections. The first extends from the front pressure bulkhead to behind the nosewheel bay; the next, and largest, piece terminates at the wing trailing edge; the third section runs back to the rear pressure bulkhead and the final piece is the extreme tail, which does not include any of the empennage.

Most of the fuselage structure is identical to that of the KC-135, although in the tanker the upper-bubble radius is 72in, two inches less than in the 707. Frames and stringers are all standard rolled sections of various channel or angle forms. Skin joints occur along strong longitudinal members or frames and are reinforced with doublers. The heaviest frames are those picking up the wing spars at stations 620* and 820; these are heavy extrusions attached to the spars by forgings. A conventional floor structure of transverse beams and longitudinals is built in at the intersection of the two bubbles, the portion of floor above the wing being made integral with the wing.

All doors above the floor—two main doors to port with slightly less wide service doors or emergency exits to starboard—are of the plug type, wider than their frames. When shut they are also of greater depth than their frames but the upper and lower edges of each door can be folded inwards and down on parallel linkages to reduce the effective depth of the door, which can then slide out edge-ways through its opening pivoting on the ends of hinged arms. Underfloor freight and service compartments are provided with simple doors on the starboard side, arranged to push in and slide on rails. Windows are very small (9in × 12½in) and are—unusually—spaced one per 20in frame.

Wing. There are two spars, with heavy sheet webs, stiffened by vertical angles, and extruded booms, the latter being of a T-form above and an angle below. Each complete wing comprises a port and starboard plane bolted to a centre section of the same width as the fuselage.

The rear spar runs straight as far as a production break at station 725, just outboard of the outer nacelles. It then adopts an increased angle of sweep but still converges gently with the front spar. From immediately outboard of the low-speed ailerons the metal tip is detachable about a line perpendicular with the rear spar. Owing to the considerable chordal separation of the spars there are many closely spaced ribs, the majority being unperforated heavy-gauge assemblies at 90 deg to the rear spar, with multiple riveted angle stiffeners. Around these ribs are attached extruded stringers, of angle or channel section, the skin being flush-riveted to the latter. Tapered-sheet skin is not used.

Nearly all the space between the spars forms giant integral tanks, the fuel being allowed to circulate through the spaces between the ribs and skin left by the depth of the stringers. Multiple inspection cut-outs are provided in the under-surface, sealed by doors screwed to rivet/nut units around their peripheries. Inboard of the inner nacelles the rib alignment changes progressively until it is fore-and-aft at the root. Several of the inner ribs have large rectangular cut-outs spanned by the vertical stiffening angles. From the root to the break-joint the underside of the leading edge hinges for access to the interior.

Tail. The fin, which is built separately from the fuselage, has two main spars and a third member along the line of the rudder hinges. The multiple plate ribs change direction at the second spar, those in line with the rudder hinges being of heavier construction.

Like the fin, the variable-incidence tailplane has two main spars and multiple plate ribs with flanged lightening holes, together with heavy ribs carrying the elevator hinges. Aft of the rear spar is a secondary structure housing the large elevator balance panels which waft up and down between the ribs. Each half-tailplane is bolted up to a centre-section box free to tilt in a rectangular cut-out in the fuselage. The centre box is bolted to a pair of forged trusses hinged along a transverse axis behind the rear spar (see "Flying Controls" overleaf).

Pods. The nacelle struts are slung from fore-and-aft strong ribs, the outer such ribs having a cruciform joint with the "normal" (i.e., perpendicular to the rear spar) rib carrying the outer flap tracks. On the front spar at each strut-position is bolted a large forged anchor providing root-fittings for the two strut spars. Below this forging there extends a strong frame, the lower end of which is triangulated back by a compression tube bolted to the underside of the fore-and-aft rib. The struts are completed by multiple, substantially vertical, chordwise members, two of which are heavy frames carrying the powerplant itself. On the Pratt and Whitney JT3C there are mounting pick-ups on top of the compressor inter-spool section, which are attached to the front strut-frame *via* a forged yoke and braced by a forged stay on each side. Forged attachments also pick up at the top of the turbine-support casing.

In its production form the nacelle strut extends right forward to terminate at a ram intake to the cabin-air turbo-compressors immediately above each main intake. The oil coolers on the JT3C nacelle are mounted on the lower flanks of the powerplants and are fed from separate intakes. Nacelle skinning is likely to be of magnesium to allow it to burn off in the event of an engine fire.

Undercarriage. The main legs are hinged to massive trunnions held against the rear of the wing box between forged fore-and-aft members known as "beaver tails" which lie along the top and bottom surfaces of

**See note 8 opposite.*