The DUMPY Pocket Book of AIRCRAFT and FLIGHT

The DUMPY Pocket Book of AIR-CRAFT and FLIGHT

Over 180 aircraft (civil and service) are illustrated and described in this *Dumpy Pocket Book*, together with brief histories and fleet lists with Registration Numbers of 48 of the world's principal Airlines, a chapter on VTOL and STOL aircraft, another chapter on the development of the airliner, and stories of some of the famous flights which made aviation history.

Identification of aircraft on back

Jindivik — Blackburn NA.39 — Radioplane RP.71
D.H. Comet 4 — Gloster Javelin
Canberra B.Mk.8 — Cessna 150 — Rotodyne
Sikorsky S.62 — Saab Draken — Cessna T.37A
Martin Seamaster — Fairey Ultra-Light — Mig 19
H.P. Victor
Piaggio P.155 — North Am.F-104 — SIPA 200
Convair F-102A — Boeing 707
Miles HDM.105 — Temco T.T.1 — Hunter Mk.6
Benson B.8M — Shackleton — Auster
Douglas DC-8 — D.H.C. Caribou

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Acknowledgments

The publishers wish to express their grateful appreciation to the Directors and Public Relations Officers of the airlines who have so willingly co-operated in the preparation of Aircraft and Flight. *Special thanks are due to Mr. John W. R. Taylor, editor of Jane's* All the World's Aircraft *for his chapters on "Famous Flights", "Development of the Airliner" and "VTOL and STOL"; to Mr. Norman Blackburn and Mr. L. E. Bradford for the Aircraft General Arrangement drawings.*

Made and printed in Great Britain by Purnell & Sons, Ltd., Paulton (Somerset) and London. This book may only be exported for sale in the following territories by the appointed sole agents: AUSTRALIA—Ponsford, Newman & Benson, Ltd. NEW ZEALAND—Whitcombe & Tombs, Ltd. AFRICA—Purnell & Sons (S.A.) (Pty) Ltd.

The Dumpy Pocket Book of AIRCRAFT AND FLIGHT

General Editor HENRY SAMPSON

SAMPSON LOW LONDON

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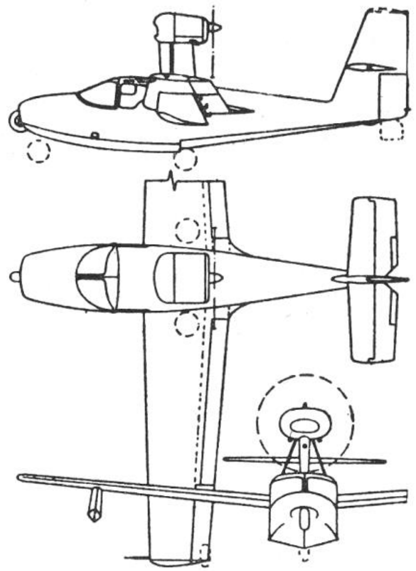


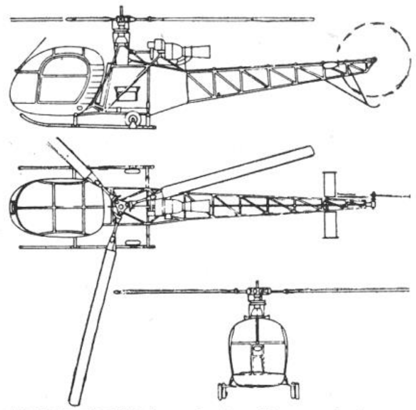
SKIMMER (one piston engine)

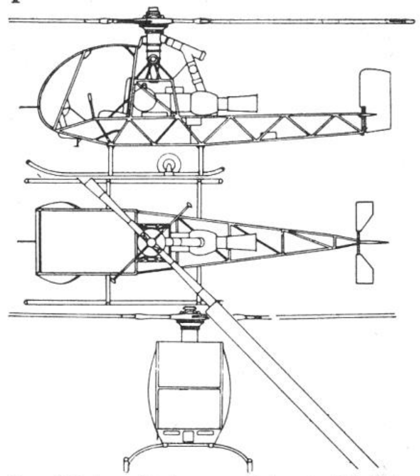
Colonial Aircraft Corp. (U.S.A.)

Single-engined 3-4 seat amphibian. One 150 h.p. Lycoming 4-cylinder horizontally-opposed air-cooled engine mounted above hull, driving a constant-speed "pusher" propeller. Cruising speed 135 m.p.h. Weight 2,350 lb. Span 34 ft. 2 in. Length 23 ft. 6 in. Height 9 ft. 4 in.

CHAPTER ELEVEN

Helicopters





ALOUETTE II (one shaft-turbine engine)

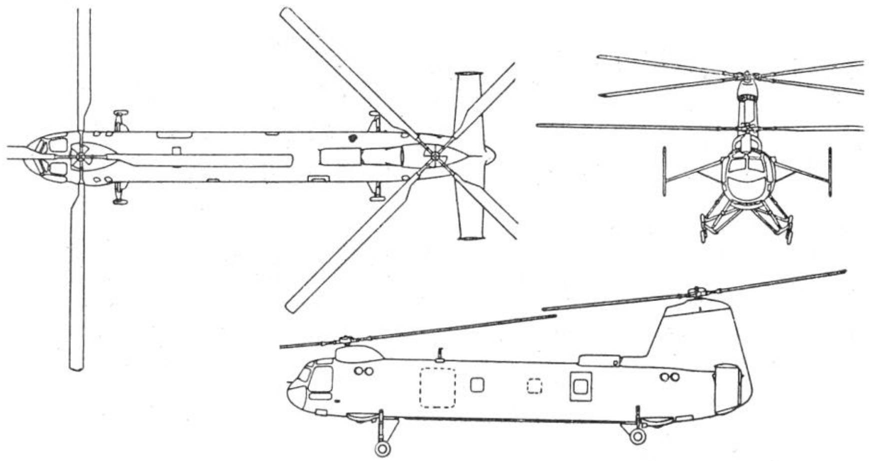
Sud-Aviation (France)

General-purpose 5-seat civil and military aircraft. One 400 s.h.p. Turbomeca Artouste II shaft-turbine engine, driving 33 ft. 6 in. 3-blade main rotor and 2-blade tail rotor. Weight 3,300 lb. Max. speed 110 m.p.h. Cruising speed 106 m.p.h. Length (blades folded) 31 ft. 6 in. Height 9 ft. 0 in.

DJINN (one turbo-compressor engine)

Sud-Aviation (France)

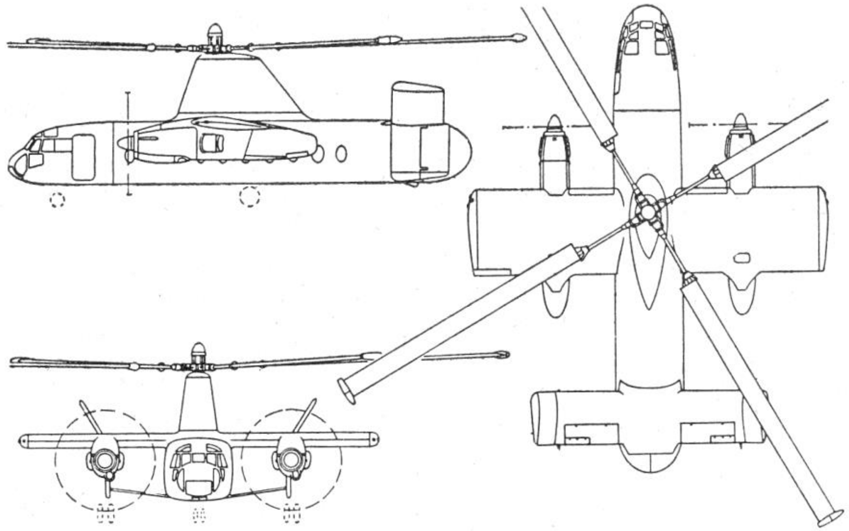
Light two-seat civil and military helicopter. One 240 h.p. Turbomeca Palouste IV turbo-compressor engine. Two-blade rotor 36 ft. 1 in. diam. rotated by the ejection of compressed air from nozzles at the blade tips. The air, supplied by the turbo-generator, is ducted to the blade tips and ejected "cold", i.e. no form of combustion is used. Weight 1,765 lb. military; 1,675 lb. civil. Max. speed 80 m.p.h. Cruising speed 66 m.p.h. Length of fuselage 17 ft. 4 in., width 6 ft. 2 in. Height 8 ft. 5 in.



BRISTOL 192 (two gas turbine engines)

Bristol Aircraft Ltd. (G.B.)

Twin-rotor passenger/freight or general-purpose military and civil helicopter, crew of 2. Cabin 24 ft. 1 in. long, accommodates 6,000 lb. of freight or 18/25 fully-armed troops or can be used as ambulance or for sea-rescue. Two Napier Gazelle 2 engines each rated at 1,650 h.p. Weight 18,000 lb. Cruising speed 138 m.p.h. Rate of climb with forward speed 1,175 ft./min. Vertical rate of climb 500 ft./min. Diam. of rotors 48 ft. 8 in. Length 89 ft. 9¼in. Height 17 ft. 0 in.



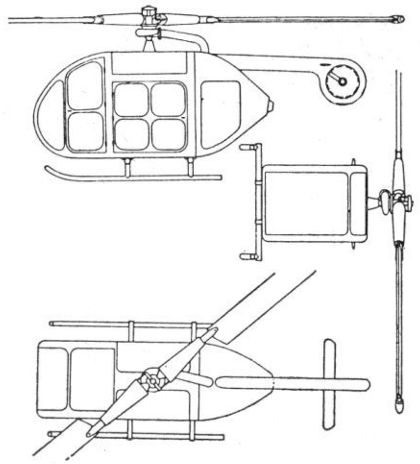
FAIREY ROTODYNE (two turboprop engines)

Fairey Aviation Co. Ltd. (G.B.)

Passenger and/or freight VTOL aircraft. Cabin 46 ft. 0 in. long, 8 ft. 0 in. wide, 6 ft. 0 in. high, accommodates 40–48 passengers or 15,000 lb. freight. **Prototype has two 3,500 e.h.p. Napier Eland turboprop engines mounted under the fixed wings. In addition to driving a Rotol 4-blade variable-pitch propeller, each engine**

FAIREY ROTODYNE continued:

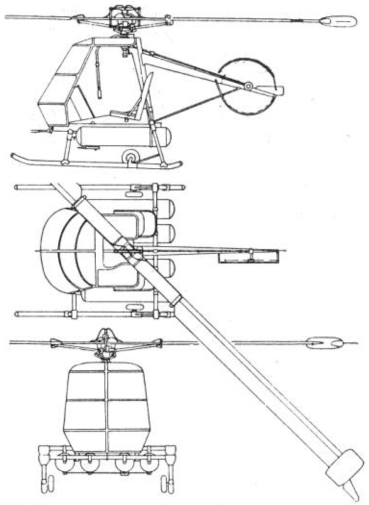
drives, via a hydraulic clutch, an air compressor from which compressed air is ducted through to the tips of the blades of the main rotor to pressure-jet units in which fuel is burned to give maximum thrust. For vertical take-off and landing and hovering the rotor pressure-jets are in full operation, the forward propellers being set to zero thrust to allow maximum engine power for driving the air compressors. For forward movement the propellers are set to give thrust and the rotor pressure-jets are not operating, the rotor auto-rotating as in an autogyro. Weight 33,000 lb. In January 1959 the Rotodyne set a world record of 191 m.p.h. on a closed circuit. Vertical climb 1,800 ft./min. Main rotor 90 ft. 0 in. diam. Length of fuselage 58 ft. 8 in. Fixed wing span 46 ft. 6 in. Height 22 ft. 2 in. Production Rotodynes will have 5,000 h.p. Tyne turbo-props and will carry up to 70 passengers at over 200 m.p.h.



FIAT 7002 (one turbo-generator engine)

S.p.A. Fiat (Italy)

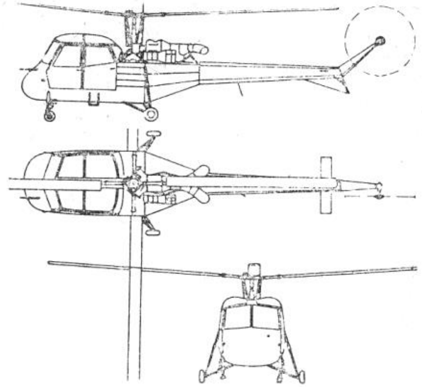
General-purpose medium-capacity helicopter, pilot and 6 passengers or 88 cu. ft. freight. One 530 gas h.p. turbo-generator engine. Two-blade main rotor 39 ft. 4 in. diam. rotated by the ejection of compressed air from nozzles at the blade tips. The air, supplied by the turbo-generator, is ducted to the blade tips and ejected "cold", i.e. no form of combustion is used. Weight 3,100 lb. Max. speed 106 m.p.h. Cruising speed 84 m.p.h. Length of fuselage 20 ft. 1 in. Height 9 ft. 5½ in.



KOLIBRIE (two ramjet engines)

Nederlandse Helicopter Industrie (Netherlands)

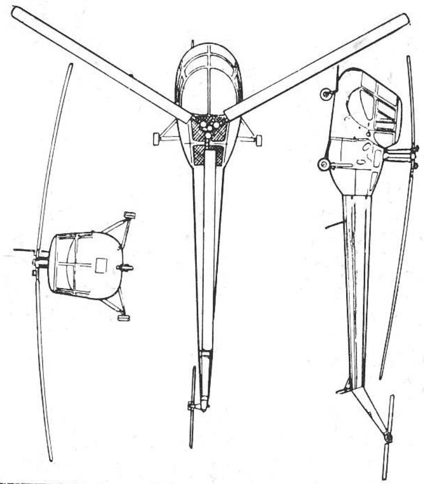
Two-seat general purpose light helicopter. The 2-blade main rotor, 33 ft. 0 in. diam., is driven by two 60 h.p. ramjets, mounted one at each blade-tip; the 2 ft. 9 in. diam. tail rotor being driven from the main rotor by gears and shaft. The main rotor is larger and four times heavier than is normal, permitting considerable overloading and some twelve times more kinetic energy for emergencies. Weight approx. 1,500 lb. Max. speed 70 m.p.h. Length of fuselage 13 ft. 10½ in. Width 6 ft. 6½ in. Height 8 ft. 6 in.



P.531 WASP (one turboshaft engine)

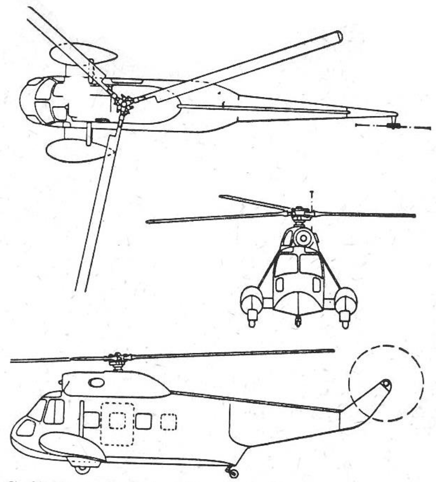
Saunders-Roe Ltd. (G.B.)

Light general-purpose civil and military helicopter. Pilot and 4 passengers or freight. Initial version has one 425 h.p. Blackburn Turbomeca Turmo free-turbine engine driving 32 ft. 3 in. main rotor. Weight 3,800 lb. Max. speed 121 m.p.h. Cruising speed 115 m.p.h. Length (blades folded) 28 ft. 0 in. Width (blades folded) 8 ft. 6 in. Height 9 ft. 6 in. Production models will have a 635 h.p. Blackburn A129 engine.



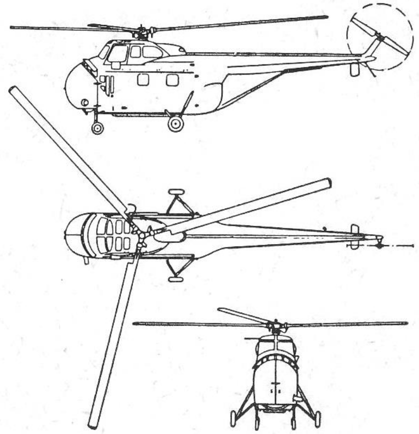
SKEETER (one piston engine)
Saunders-Roe Ltd. (*G.B.*)

Light two-seat general purpose helicopter. One 200 h.p. or 215 h.p. Gipsy Major 4-cylinder inverted air-cooled engine driving 32 ft. 3-blade main rotor and 2-blade anti-torque rotor. Weight 2,250 lb. Max. speed 104 m.p.h. Vertical rate of climb 425 ft./min. Length (blades folded) 28 ft. 5 in. Length of fuselage 26 ft. 6 in. Width (blades folded) 7 ft. 4½ in. Height 7 ft. 6 in.



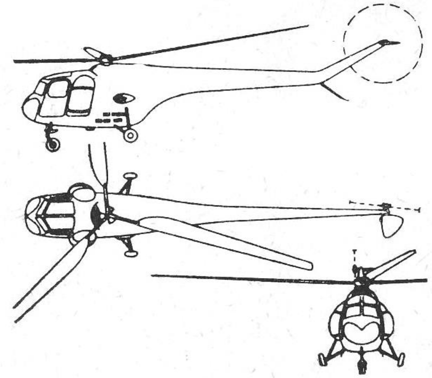
S-62 (one shaft-turbine engine)
Sikorsky Aircraft Division of United Aircraft Corp. (*U.S.A.*)

General-purpose amphibious helicopter. Cabin 14 ft. long, accommodates 8–12 passengers. One 1,050 s.h.p. General Electric T58 shaft-turbine engine, driving 53 ft. diam. 3-blade main rotor and 8 ft. 9 in. diam. anti-torque rotor. Weight 7,500 lb. Payload 1,700 lb. Max. speed 130 m.p.h. Cruising speed 92 m.p.h. Vertical rate of climb 450 ft./min. Fuselage length 44 ft. 7 in. Height 14 ft. 2 in.



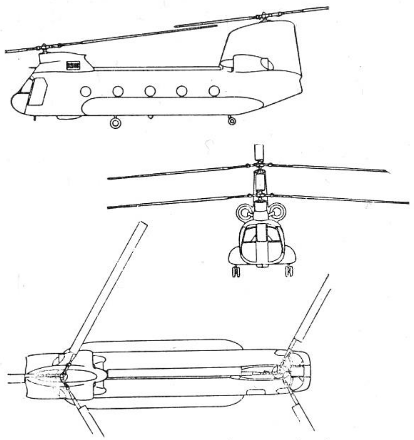
S-55 (one piston engine)
Sikorsky Aircraft (*U.S.A.*)

General-purpose civil and military helicopter, used for passengers (12 seats), freight and air rescue services. One 600 h.p. Pratt & Whitney R-1340 radial air-cooled engine, driving 53 ft. diam. 3-blade main rotor and 8 ft. 9 in. diam. tail rotor. Weight 7,200 lb. Max. speed 101 m.p.h. Cruising speed 85 m.p.h. Length of fuselage 42 ft. 2 in. Height 13 ft. 4 in.



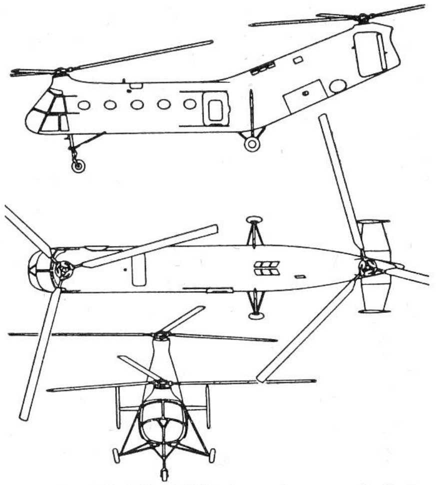
BRISTOL SYCAMORE (one piston engine)
Bristol Aircraft Ltd. (*G.B.*)

Civil or military 4–5 seater. Three-blade main rotor 48 ft. 6½ in. diam. and three-blade tail rotor 9 ft. 7¼ in. diam. One 520 h.p. Alvis Leonides 9-cylinder radial air-cooled engine. Max. speed 127 m.p.h. Cruising speed 91–107 m.p.h. Max. climb at forward speed 1,300 ft./min. Vertical climb 420 ft./min. Weight 5,600 lb. Length (main rotor folded) 46 ft. 2 in. Height 12 ft. 2 in.



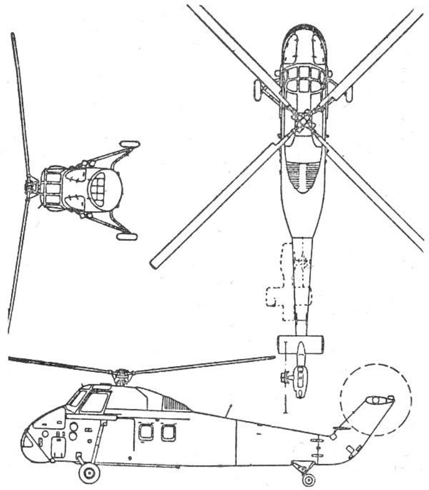
VERTOL 107A (two turbine engines)
Vertol Aircraft Corporation (U.S.A.)

Twin-rotor civil and military transport helicopter with accommodation for 23–30 passengers. Two General Electric T58 shaft-turbines totalling 2,900 s.h.p. or two Lycoming T53 shaft-turbine engines, totalling 1,700 s.h.p., mounted side by side above the cabin roof line in the rear rotor pylon. Diam of each rotor 48 ft. 4 in. Length (blades folded) 44 ft. 3½ in. Height 17 ft. 7½ in. Loaded weight 15,550 lb. Max. speed 160 m.p.h. A larger version is in production for the U.S. Army as the YHC-1 Chinook.



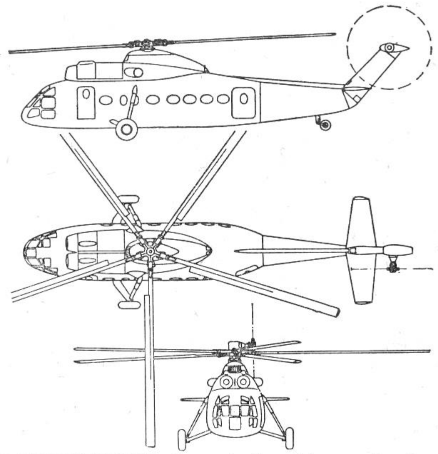
WORK HORSE H-21B (one piston engine)
Vertol Aircraft Corporation (U.S.A.)

Troop and cargo transport helicopter, accommodating 12 stretchers or twenty troops in cabin, with passenger/cargo compartment 20 ft. long, 5 ft. 8 in. wide, 5 ft. 6 in. high, and two crew. One 1,425 h.p. Wright R-1820-103 engine driving two rotors diam. 44 ft. each. Length with rotors turning 86 ft. 4 in. Width (blades folded) 14 ft. 4 in. Height 15 ft. 5 in.



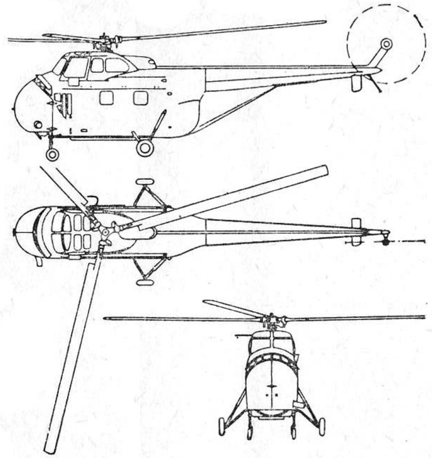
WESSEX (one shaft-turbine engine)
Westland Aircraft Ltd. (G.B.)

A general-purpose helicopter which the Royal Navy will use also for anti-submarine duties. Can accommodate twelve passengers and baggage or eight stretchers or 4,000 lb. of freight, or an external sling load of 4,000 lb. One 1,430 s.h.p. Napier Gazelle NGa13 shaft-turbine engine in nose, driving 4-blade main rotor and tail rotor. Length 65 ft. 9½ in. Height 15 ft. 10 in. Weight 12,600 lb. Max. speed 144 m.p.h.



WESTMINSTER (two shaft-turbine engines)
Westland Aircraft Ltd. (G.B.)

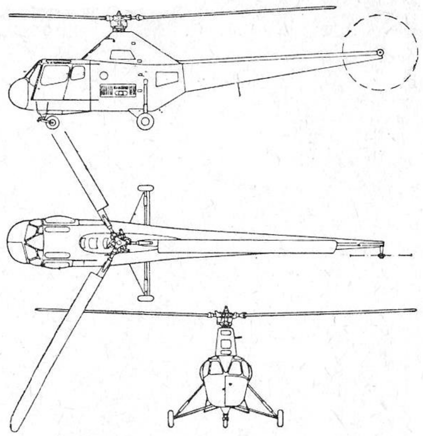
A general-purpose civil and military helicopter accommodating 50 passengers in cabin and with a freight capacity of 253 cu. ft. at rear. Two 3,150 s.h.p. Napier Eland E.229A shaft-drive turbines mounted forward above the cabin with gear-box for main rotors immediately behind. Main rotor has five blades, diam. 72 ft. Tail anti-torque rotor has four blades, diam. 15 ft. Length 89 ft. 4 in. Height 19 ft. 6 in. Weight 36,000 lb. Cruising speed 115 m.p.h.



WHIRLWIND SERIES 1 (one piston engine)

Westland Aircraft Ltd. (G.B.)

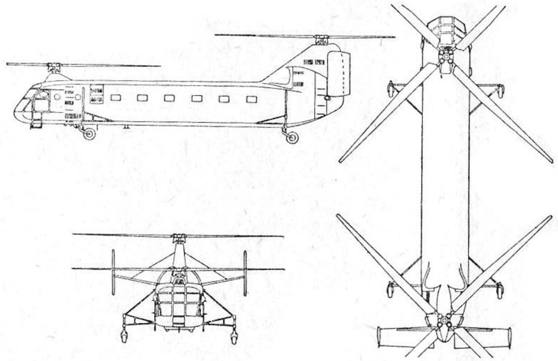
A general-purpose civil or military helicopter. One 600 h.p. Pratt & Whitney R-1340 9-cylinder air-cooled radial engine in nose, driving main rotor gearbox by sloping shaft. Diam. of all-metal three-blade main rotor 53 ft. Anti-torque two-blade tail rotor diam. 8 ft. 11 in. Length 62 ft. 1½ in. Width 45 ft. 9½ in. Height 13 ft. 3 in. Weight of civil version 7,500 lb. Max. speed 109 m.p.h.



WIDGEON (one piston engine)

Westland Aircraft Ltd. (G.B.)

A light general-purpose civil or military helicopter seating five. One 375 h.p. Alvis Leonides 521/2 9-cylinder air-cooled radial engine mounted horizontally above centre-section bottom truss, driving 3-blade all-metal 49 ft. 2 in. main rotor. Shaft drive from main rotor to 8 ft. 5 in. anti-torque tail rotor. Length 40 ft. 10 in. Width 5 ft. 10 in. Height 13 ft. 2¾ in. Weight 5,900 lb. Max. speed 104 m.p.h.



YAK-24 (two piston engines)

A. S. Yakovlev (U.S.S.R.)

A tandem-rotor transport helicopter with crew of three or four in forward cabin. Centre cargo space or cabin, 33 ft. long for transport vehicles, equipment, or up to 40 people. Opposite-rotating 4-blade rotors interconnected by torsion shaft, but driven by separate engines. Two 1,700 h.p. ASh-82V 14-cylinder radial air-cooled engines, each of which will drive both rotors if necessary. Rotors diam. approx. 68 ft. 11 in. (later models 79 ft.). Length approx. 92 ft. Height approx. 23 ft. Weight 32,275 lb. Approx. cruising speed 127 m.p.h.

CHAPTER TWELVE

VTOL and STOL

In the early days of flying all aircraft came into the VTOL (vertical take-off and landing) or STOL (short take-off and landing) categories. Balloons, in which men first left the ground in 1783, were VTOL aircraft. As soon as the ropes which held them down were released they rose vertically, requiring "airfields" little bigger than the diameter of their envelope. Even the Wright biplanes of 1904–10, first powered aeroplanes to fly properly, were catapulted into the air from a short track in a distance of some 50 ft.

Unfortunately, both the balloon and the Wright biplane had their limitations. Once in the air, the balloonist had no choice but to go where the wind carried him. It was too much to hope that the wind would begin to blow in the opposite direction at the right moment, so his journeys were strictly one-way. Similarly, the dependence of the skid-undercarriage versions of the Wright biplane on their launching catapult restricted their freedom of movement. They normally flew in circles, landing back at their starting point, near the catapult.

That is why the other pioneers of flying rejected catapults and skids, and fitted wheels to their aeroplanes. But in time this development also began to limit the aeroplane's usefulness. It was all right while weights were low and speeds slow, and to this day there are lightly-loaded single-seat sportsplanes that will take off and land in tiny fields: but the average modern aeroplane is far from lightly loaded and needs a very long take-off and landing run.

One does not have to know very much about aerodynamics to understand why. A wing develops lift when air flows over it. The faster the air flows over the wing (or the faster the wing moves through the air, which is the same thing) the more lift will be developed, at normal subsonic speeds. As a result the aircraft designer is faced with two alternatives:

1. To fit big wings, which will give plenty of lift at comparatively low speeds. These will enable the aircraft to get off the ground after quite a short run, but will offer a lot of drag in flight and therefore limit the aircraft's speed.
2. To fit small wings, which will offer less drag but will have to move through the air much faster than the large ones to develop the same amount of lift and will therefore require a longer take-off run.

For the sake of high cruising speeds, most designers have to choose the second alternative, and the average military fighter and bomber, or long-range airliner, needs anything up to two miles of runway along which to hurtle before it can lift itself into the air.

Of course, the terms "big" and "small" as applied to wings must be kept in perspective. The wings of a Boeing 707-436 jet airliner of the kind flown by B.O.A.C. are very big indeed in

physical size, spanning 142 ft. 5 in., with an area of 2,892 sq. ft. But they have to lift a 315,000 lb. aeroplane into the air, so that every square foot of wing has to lift nearly 109 lb. By comparison, each square foot of the original 1903 Wright biplane's wings had to lift less than $1\frac{1}{2}$ lb. (this figure is known as the wing loading). So, despite their size, the wings of a 707 are tiny in relation to the job they have to do.

In exchange for ever-increasing speeds, we have therefore had to accept ever-longer take-off and landing runs. It is a high price in terms of pounds, shillings and pence, because a modern runway costs around £450 for every foot of length and an airport such as London or New York International must provide runways at least 9,500 ft. long.

There are even less happy sides to the picture. For example, most accidents occur during take-off and landing, especially in bad weather, and the safest aeroplane is the one that takes off and lands most slowly in the shortest distance. Furthermore, it is seldom possible to build huge runways near to city centres, with the result that passengers travelling on short routes such as London-Paris spend far longer in coaches riding between city-centres and airports than they do in the air.

Little wonder that some designers—all too few—have spent their lives trying to produce aircraft that would take off and land vertically, and yet offer reasonable cruising speeds and a degree of controllability and manoeuvrability in the air at least as good as a conventional aeroplane.

One answer to the problem looks very simple on paper:

In a normal fixed-wing aeroplane the speed at which the wing moves through the air is directly related to the forward speed of the aeroplane Why not, then, let the aeroplane stand still and spin its wings round like the sail of a windmill, but horizontal instead of vertical? Air will then flow over the wings and develop lift even when the aircraft is stationary. The result of this line of thought is familiar to us nowadays in the shape of the helicopter, which develops so much lift from its rotating wing that it can take off and land vertically with no forward run at all, and can even hover in the air.

Unfortunately, in engineering one never gets something for nothing and we have to pay a high price for the helicopter's VTOL capabilities. As a start, a fixed-wing lightplane such as the Cessna 172 will carry four people at 124 m.p.h. on the power of a 145 h.p. engine. A helicopter like the Bristol Sycamore needs a 500 h.p. engine to carry the same number of people at 107 m.p.h., in order to provide sufficient power to take off and land vertically. As a result a helicopter is very much more expensive to buy and to operate than a comparable fixed-wing type.

Secondly, it is unlikely that helicopters will ever fly at much more than about 200 m.p.h., because at this speed the tips of the rotor blades are approaching the speed of sound as they move forward through one half of their turning circle. Considerable vibration would result if the tips were allowed to reach sonic speed and the helicopter would become difficult to control, even if it did not break up.

Within these limitations, the helicopter is the VTOL aircraft for which we have waited. It will do many jobs better than other aeroplanes and some which they cannot do at all. Even for passenger-carrying on a short route such as

London-to-Paris, the ability of a 150 m.p.h. helicopter to take off and land at city-centre heliports would enable it to halve the present journey time by airline coaches and a 300 m.p.h. fixed-wing airliner. So the helicopter is likely to be with us for many years: but that is not stopping designers from seeking a more efficient, or cheaper, type of VTOL or STOL aircraft.

Some of them are putting their money on what is known as a convertiplane. This is a mixture of helicopter and fixed-wing aeroplane which converts from one to the other at different stages of flight—hence its name.

To understand why this is a good thing, let us think back to the helicopter for a moment. In this the rotor not only replaces the wings of a fixed-wing aeroplane, but the propeller as well: in other words the rotor has to provide thrust for forward flight as well as lift—both at the same time. To increase speed the rotor has to be turned faster and, as we have seen, there is a limit to how fast it can be turned.

The ideal, obviously, would be to fit a conventional aeroplane with a rotor that could be used for vertical take-off, after which it would be folded up until required for landing at the other end. Quite apart from the difficulties of folding and stowing the rotor, the period between the top of the vertical climb and the moment when the aircraft was flying at a fairly high speed in normal cruising flight would be, to say the least, full of interest!

Several ways of bridging this transition from vertical to forward flight have been tried, with varying degrees of success. The American Bell XV-3, for example, has tilting rotors at the end of fixed wings. It takes off like a helicopter with the rotors horizontal (i.e. the rotor drive-shafts are vertical). At a safe height the rotors begin to move forward through 90°. As they do so they gradually give more thrust and less lift. This makes the aircraft move forward at ever-increasing speed, and as it gathers speed the fixed wings provide more and more lift. Eventually, the wings give all the lift needed to keep the XV-3 airborne and its rotors are able to work as conventional, if outsize, propellers.

A rather more promising alternative is offered by the giant Fairey Rotodyne. This can best be imagined as an ordinary twin-turboprop fixed-wing airliner in which the wings have been cut to half their normal size. the missing portions being replaced by a big four-bladed helicopter rotor. During take-off, the two turboprop engines drive auxiliary compressors which supply compressed air to pressure-jet engines mounted on the rotor blade-tips. The pressure-jets turn the rotor and the Rotodyne takes off like any other helicopter.

At a safe height the power of the turboprops is transferred gradually from the auxiliary compressors to the forward-facing airscrews, and the aircraft begins to move forward at steadily mounting speed. Eventually, the wings provide so much lift that the pressure-jets can be shut off, leaving the rotor to windmill freely in the airflow. This is the normal cruising condition, with lift coming from both the fixed and rotating wings, and all the engine power available to drive the propellers. The result is a much higher cruising speed than is possible with a pure helicopter, and within a few years 65-seat Rotodynes will be linking city centres at well over 200 m.p.h.

The type of convertiplane represented by the Rotodyne has a rival in the tilt-wing aircraft, of which the Hiller X-18 is typical. This works in

much the same manner as the tilting-rotor XV-3, except that the entire wing tilts. In the X-18, two turboprop engines are mounted on the wing in the normal way, driving contra-rotating propellers of much smaller diameter than the XV-3's rotors. The mechanism needed to tilt the wings is fairly heavy, but the propellers are more efficient than rotors and the transition from vertical to horizontal flight, while the wing is tilting, apparently presents no difficulties, as the normal flying controls are supplemented by air jets at the tail to keep the machine straight and level.

With all their advantages, there is no disputing the fact that helicopters and convertiplanes are complicated machines. That is why another group of designers is trying to adapt the ordinary fixed-wing aeroplane into a VTOL, or at least an STOL, aircraft.

We have seen for many years how the lift of a wing can be improved by the use of such devices as leading-edge slots and large trailing-edge flaps, to the point where machines like the Scottish Aviation Twin Pioneer will take off and land very slowly in confined spaces. It is possible to improve the slow-flying qualities of an aircraft still further by the use of systems such as boundary layer control and "flap blowing". These are too diverse and technical to describe in detail here; but the basic principle of all of them is to keep the air flowing either more smoothly over the top surface of a wing and its flaps, or faster. In each case there is a considerable improvement in lift, making possible slower, safer landings and take-offs. The price paid is the addition of a source of power either to suck the turbulent "boundary layer" of air inside the wing or to provide a stream of high-speed air over the flaps.

A variation on this theme is the "blown-wing" aircraft, typified by the Breguet 940 Integral. This is a fairly normal fixed-wing aeroplane, but is fitted with very large and efficient slotted flaps. In addition, its propellers are of larger diameter than usual, so that their slipstream blankets the entire wing-span. The combination of slipstream and flaps is claimed to get the 14,700 lb. Integral into the air in only 200 ft., with a subsequent cruising speed of up to 236 m.p.h. Eventually, Breguet believe that such a technique could combine true VTOL characteristics in a reasonable wind with very high cruising speeds.

So far, we have thought in terms of using fairly straightforward rotors or propellers; but plenty of other lift- and thrust-producing sources are available. The Doak VZ-4DA, for example, is similar to the Bell XV-3 convertiplane, except that the latter's rotors are replaced by what are called ducted fans or ducted propellers.

In brief, a small rotor or propeller surrounded by a ring-shaped duct will give the same thrust as an unducted propeller of greater diameter. As a result, the quite small tilting ducted fans on the end of the VZ-4DA's wings do a better job than the 25-ft. rotors of the XV-3.

Another aircraft that uses a ducted fan is the little Hiller "Flying Platform". In this, the pilot stands on a platform above the fan. He is able to take off vertically, helicopter-fashion, and moves forward by simply leaning forward, so that the whole machine tilts slightly and the propellers give some forward thrust as well as lift. He changes course by leaning in the direction he wants to go.

Big snag of such a machine is that there is nothing to keep it up if the engines fail, because the propellers are not big enough to permit auto-rotative engine-off landings of the kind possible with a helicopter. But this is not serious in vehicles designed to skim close to the ground and a whole series of "Flying Jeeps" with ducted-fan engines are under development in America. In most cases, their direction of flight is controlled by means of vanes working like aircraft control surfaces in the slipstream under the fans.

"Jeeps" of this kind could do all the jobs performed by the familiar four-wheel type, even where there were no roads, bridges or tracks of any kind. However, if we want really high speeds we must turn to jet power in the form of direct jet lift.

Basically, this is no different from the technique used in the little Hiller "Flying Platform" or any other VTOL aircraft. It consists simply of "blowing down" a stream of air sufficiently hard to raise the aircraft off the ground by the "equal and opposite reaction" specified in Newton's third law of motion. In other words, if we mount a jet engine of, say, 10,000 lb. thrust vertically in any kind of aircraft weighing less than 10,000 lb., the aircraft can be raised off the ground by opening up the engine to full power. We saw the earliest example of this in the Rolls-Royce "Flying Bedstead", which was raised off the ground by the direct jet lift of two Nene turbojets and controlled directionally by the use of jets of compressed air in front, behind and to each side of it. Used differentially, these tilted the whole aircraft, to provide a thrust component as well as lift, in exactly the same way as when the pilot of the "Flying Platform" leans to tilt his machine.

A variation of the same idea is the French Coléoptère, which consists of a powerful Atar turbojet with a cockpit mounted on the front, or top, and an annular (ring-shaped) wing. This aircraft sits on its tail for take-off, is thrust vertically into the air by the jet and simply arches over at a safe height to fly like any other aeroplane. There is little reason why such a machine should not combine VTOL capabilities with supersonic speed; but the Coléoptère in its present form would not do for passenger-carrying, because its pilot lies semi-reclined for take-off, which is not over-comfortable.

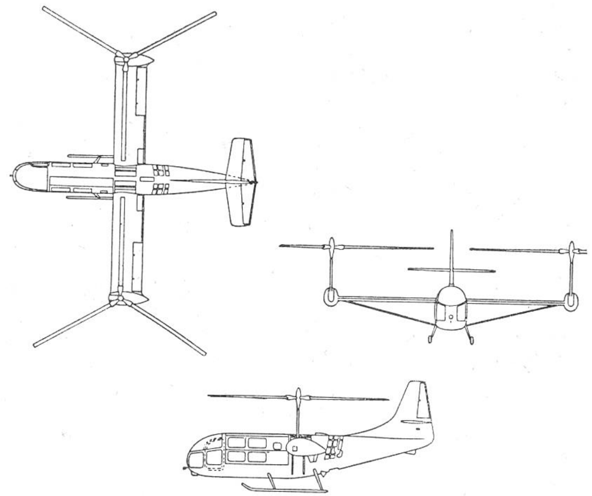
However, direct jet lift provides the answer here, too. The Rolls-Royce "Flying Bedstead" has been followed by the Short S.C.1 research aircraft in which the fuselage again remains horizontal at all times. The S.C.1 has four small upward pointing jets to thrust it vertically off the ground at take-off. Once in the air a fifth engine in the tail is opened up to drive it forward in the usual way, and when its delta wings develop sufficient lift to keep it airborne the upward-pointing jets are switched off.

One day, huge supersonic airliners might use batteries of upward-pointing jets in this way. Nor need the jets be used only at take-off and then be carried as dead weight for the rest of the trip, for Bristol have developed a new jet-engine known as the B.E.53 in which a system of "eye-lid" jet-deflection shutters can be used to "bend" the jet in any required direction. The same jet engine can therefore be used to provide lift for take-off and thrust for cruising flight.

A civil airliner using direct jet lift is many years away and today "VTOL" is still synonymous with "helicopter". But the new techniques are being improved every day and eventually runways may be as much relics of the past as the hydrogen balloon and the Wright biplane.

CHAPTER THIRTEEN

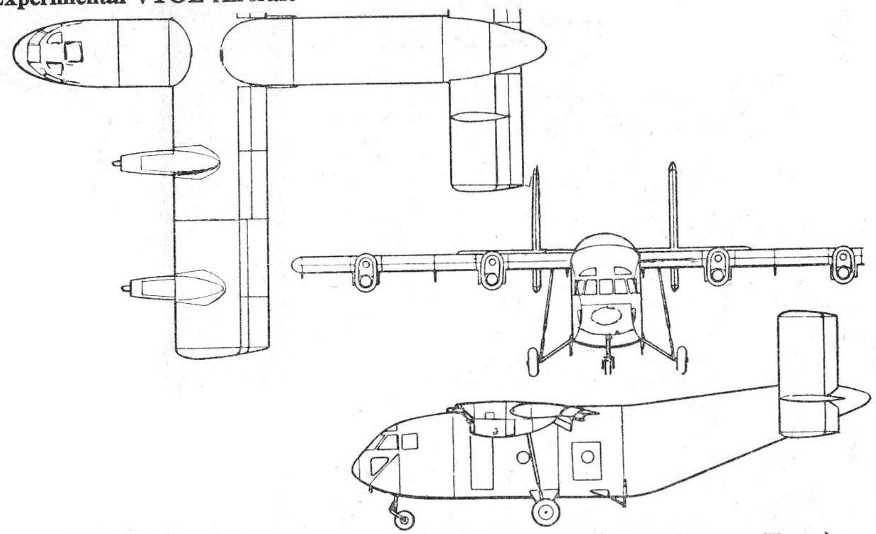
Experimental VTOL Aircraft



BELL XV-3 (one piston engine)

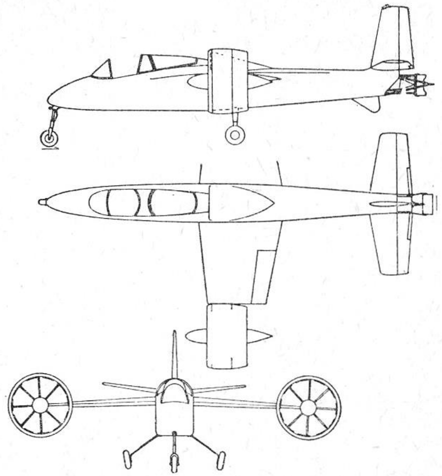
Bell Helicopter Corporation (*U.S.A.*)

Experimental VTOL convertiplane with tilting rotors 25 ft. diam. mounted on wings and shaft-driven from the 450 h.p. Pratt & Whitney R-985 piston engine. For vertical movement the rotors operate horizontally, being tilted forward gradually to give forward movement until they operate as propellers, with all lift supplied by the wings. Span 30 ft. 0 in. Length 30 ft. 0 in. Height 13 ft. 6 in. Max. speed 175 m.p.h.



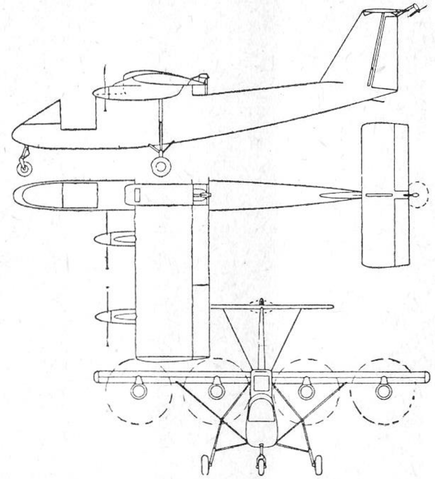
BREGUET 940 INTEGRAL (four shaft-turbine engines) *Aviation Louis Breguet (France)*

Experimental VTOL/STOL aircraft with propellers equally spaced out to ensure the slipstream blows over whole area of wings. Large-area slotted flaps on wing trailing edge provide greatly increased lift and slow forward speed at take-off and landing. With weight of 14,700 lb. the take-off run is 200 ft. Four 400 s.h.p. Turbomeca Turmo II free turbine engines each driving 3-blade variable-pitch propeller 13 ft. 1 in. diam. All propellers are interconnected by a transverse shaft to ensure continued rotation if an engine failed. Span 57 ft. 5 in. Length 39 ft. 4 in. Max. cruising speed 236 m.p.h. Landing speed 28 m.p.h.



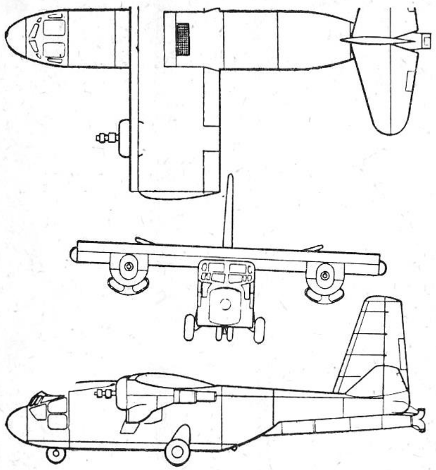
V2-4DA 16 (one shaft turbine engine)
Doak Aircraft Co. Inc. (U.S.A.)

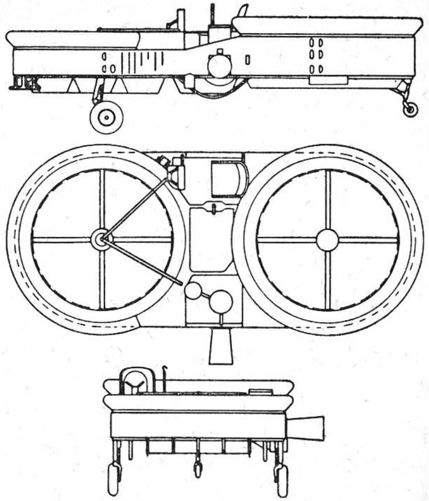
Experimental VTOL aircraft with tilting ducted propellers at wing tips. The ducted propellers, shaft-driven from a Lycoming T53 shaft turbine, developing 840 s.h.p., are tilted gradually from horizontal for vertical movement, to vertical for full forward flight with wings providing all the lift. Span 25 ft. 6 in. Length 32 ft. 0 in. Height 10 ft. 0 in.



FAIRCHILD M-224-1 (one shaft-turbine engine)
Fairchild Engine and Airplane Corp. (U.S.A.)

Experimental VTOL-STOL aircraft with large-area flaps. Four propellers, shaft-driven from the engine mounted above the fuselage, blow their slipstream over the whole area of the wings and flaps. A small tail rotor assists control during vertical and slow speed movement.





HILLER X-18 (two turboprop engines)

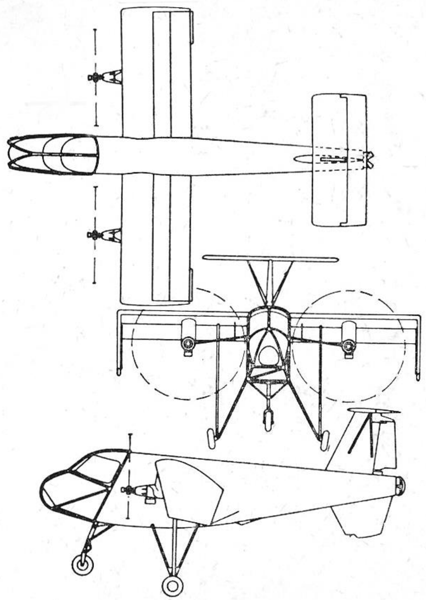
Hiller Aircraft Corp. (*U.S.A.*)

Experimental VTOL convertiplane with tilting wings. For vertical movement the wings with engines are pivoted through 90° until the propellers are horizontal and can act as helicopter rotors. The transition from vertical to full forward movement in flight is made by gradually altering the angle of the wing. Max. speed approx. 250 m.p.h.

VZ-8P FLYING JEEP (one-shaft turbine engine)

Piasecki Aircraft Corp. (*U.S.A.*)

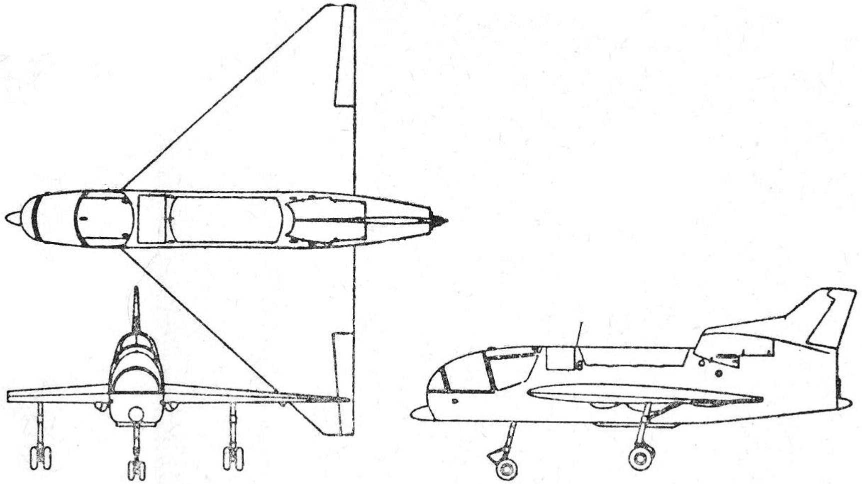
Experimental VTOL aircraft of unusual design with fixed horizontal ducted propeller/rotors at front and rear. The rotos are driven by a 425 s.h.p. Turbomeca Artouste IIB shaft-turbine. Max. speed about 150 m.p.h. The Flying Jeep is intended for military duties but a civilian version, the Sky-Car, is planned.



VZ-3RY VERTIPLANE (one shaft-turbine engine)

Ryan Aeronautical Co. (*U.S.A.*)

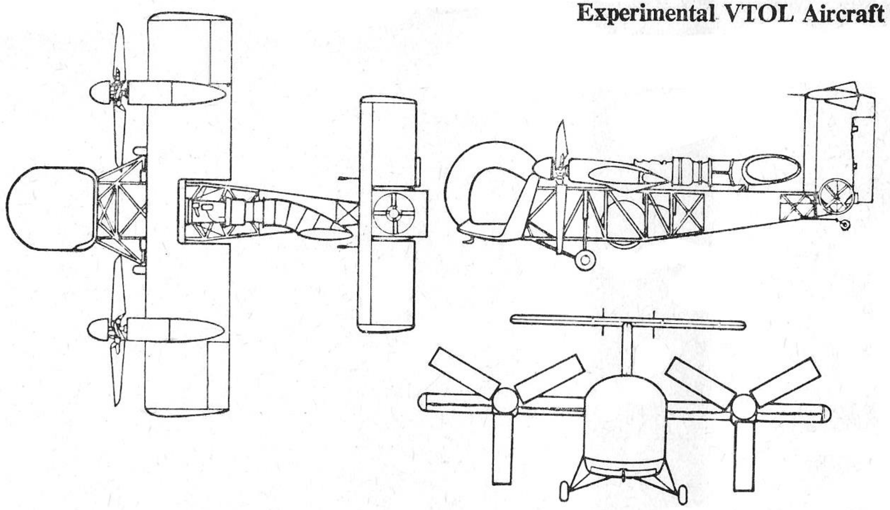
Experimental VTOL aircraft with large-area flaps and with endplates at wing-tips to confine the slipstream. One 1,000 s.h.p. Lycoming shaft-turbine engine driving two 3-blade propellers. For VTOL the flaps are fully extended, being gradually retracted for transition into horizontal flight. Span 23 ft. 5 in. Length 27 ft. 9 in. Height 10 ft. 8 in. Weight 2,600 lb.



SHORT S.C.1 (five turbojet engines)

Short Bros. & Harland Ltd. (*G.B.*)

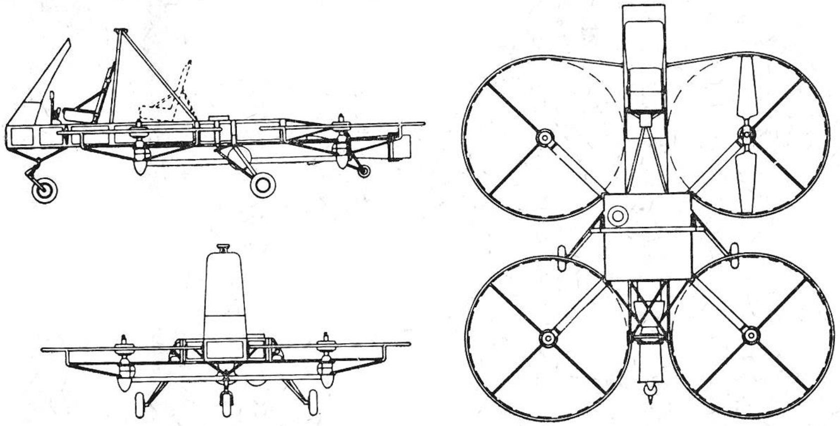
Experimental VTOL delta-wing aircraft to provide data for design of supersonic VTOL and STOL aircraft. Five Rolls-Royce RB.108 turbojet engines each rated at 2,100 lb. thrust; one mounted horizontally and four mounted vertically, these latter can be swivelled so that the thrust can be directed 30° forward or rearward. Control during vertical and hovering flight is by emission of compressed air from nozzles at wing-tips, nose and tail. Span 23 ft. 6 in. Length 24 ft. 5 in.



VERTOL 76 (one shaft-turbine engine)

Vertol Aircraft Corporation (*U.S.A.*)

Experimental "tilt-wing" VTOL aircraft. One 865 s.h.p. Lycoming T53 shaft-turbine engine driving two rotor/propellers mounted on the wing, plus a vertical and a horizontal ducted fan in the tail for additional stability and control. The complete wing is hinged, and can be tilted gradually from vertical to horizontal for the transition from vertical to forward movement, the fuselage remaining horizontal. Span 24 ft. 11 in. Length 26 ft. 5 in.



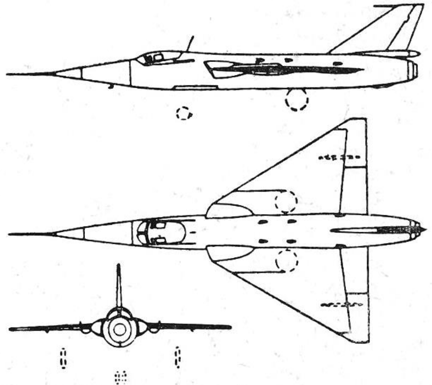
VZ-7AP FLYING PLATFORM (one shaft-turbine engine)

Curtiss-Wright Corporation (U.S.A.)

Experimental VTOL wingless aircraft. One 425 h.p. Continental Turbomeca Artouste II shaft-turbine, driving four horizontal rotors. Capable of lifting a payload of 1,000 lb. with a tare weight of 1,000 lb.

CHAPTER FOURTEEN

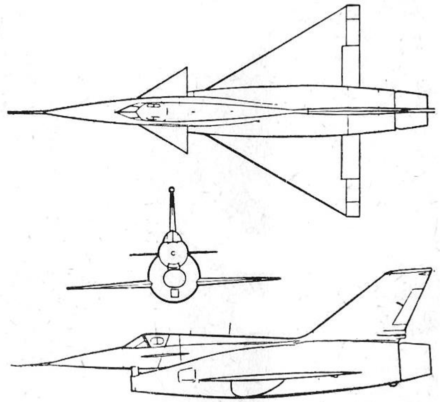
Research Aircraft



FD.2 (one turbojet engine)

Fairey Aviation Ltd. (G.B.)

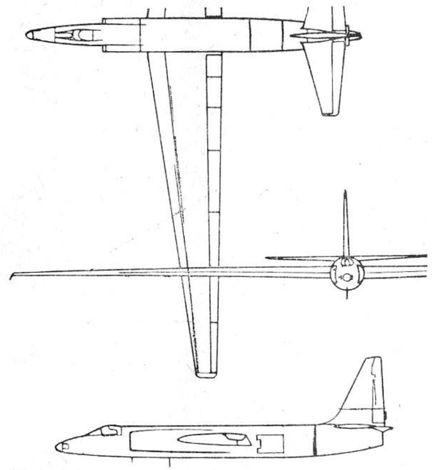
Single-seat supersonic research aircraft with 60° swept-back delta wing of 360 sq. ft. area. Set up a world's speed record of 1,132 m.p.h. in March 1956. During take-off and landing, nose section including cockpit can be angled 10° downwards for better vision ahead. Light alloy construction with pressurised air-conditioned cabin and a Martin-Baker ejection seat. One Rolls-Royce Avon 200 series turbojet engine with reheat and variable-area nozzle. Span 26 ft. 10 in. Length 51 ft. 7 in. Height 11 ft.



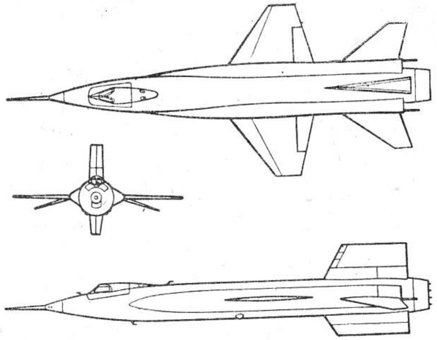
GRIFFON O2 (one turbo-ramjet engine)

Nord Aviation (France)

Single-seat supersonic experimental and research aircraft with combined turbo-ramjet power plant. One 7,700 lb. SNECMA Atar 101 turbojet is mounted inside a Nord annular ramjet, the latter being ignited for high speed operation. Max. speed is above Mach 2. In February 1959 the Griffon O2 set up a world speed record over the 100 km. closed circuit at 1,018 m.p.h. Weight 14,840 lb. Span 26 ft. 7 in. Length 47 ft. 8½ in. Height 16 ft. 6 in.



LOCKHEED U-2 (one turbojet engine)
Lockheed Aircraft Corporation (U.S.A.)
High-altitude meteorological research single-seat aircraft. One Pratt & Whitney J57 turbojet, 12,000 lb. thrust. Tandem double-wheel undercarriage with jettisonable wheels under wings for take-off the aircraft tipping on to turned-down wing-tip on landing. Operates at over 50,000 ft. to gather meteorological data. Span 90 ft. 0 in. Length 45 ft. 0 in. Max. speed Mach 0·75.



NORTH AMERICAN X-15 (one rocket engine)
North American Aviation Inc. (U.S.A.)
Single-seat space-research aircraft designed to obtain data on problems of heating, stability and control and re-entry into the atmosphere. Capable of attaining a height of 100 miles at least, with a max. speed of Mach 5 plus (3,500–4,000 m.p.h.). One Reaction Motors rocket engine rated at 50,000 lb. thrust at sea level, and 60,000 lb at peak altitudes. Wings are very thin. The dorsal and ventral fins are wedge-shaped with 12-in. wide trailing edge, the lower fin being jettisoned before landing.

CHAPTER FIFTEEN

Famous Flights

The Wright Brothers. At 25 minutes to eleven on the morning of December 17, 1903, one of the most important events in history occurred on the quiet beach at Kitty Hawk, North Carolina. With a mere handful of men looking on, a young bicycle-maker named Orville Wright lay down on the lower wing of a frail-looking biplane, started its home-made engine and, after a few minutes, released a wire which held it to a wooden track. As it moved clumsily forward into a 31-m.p.h. wind, his brother Wilbur steadied the wing-tip, running with the aeroplane until it left the track and climbed into the air to make the first-ever controlled and sustained flight by a powered aeroplane.

That first flight lasted only 12 seconds, during which the Wright biplane covered a distance of 120 ft. In three more flights that day, piloted by the brothers alternately, it flew gradually further, travelling 852 ft. in 59 seconds on the last. It was a small beginning, but within two years the Wrights progressed to the stage where they could remain airborne more than half an hour at a time. Their triumph resulted from the fact that they introduced science to aviation, testing models of their wings in a wind tunnel and progressing slowly by means of a series of gliders before building their powered aeroplane. The machine itself was a dead-end design, but the Wrights' great achievement inspired those who saw them in flight and realised that the air had been conquered at last.

Santos-Dumont. The dapper little Brazilian pioneer Alberto Santos-Dumont was the idol of Paris in the early 1900's. At a time when ballooning was still fashionable, he sometimes flew into the heart of the city in one of his tiny powered airships and parked it outside his club while he had lunch. So it was hardly surprising that when he turned his attention to aeroplanes, even those who had previously looked with disdain on would-be pilots turned up at Bagatelle to watch him.

His aeroplane looked even less airworthy than the 1903 Wright, with a box-kite tail stuck out in front of a pair of box-kite wings and a pusher propeller, so that the machine appeared to fly backwards. However, it did fly—a distance of 197 ft. on October 23, 1906, and 722 ft. a month later, when it also set up the first official world air speed record of 25·65 m.p.h. These are recognized as being the first real flights in Europe.

J. A. D. McCurdy. Progress with aeroplanes might have been much slower but for the restless spirit of Dr. Alexander Graham Bell, the great Canadian inventor who, in October 1907, formed an Aerial Experiment Association and brought together four young men, each of whom built an aeroplane. One of them was Glenn Curtiss, who went on to become the greatest U.S. pioneer after the Wrights, designing the first really