**ROTARY-WING POWER**

_A Review of Present Practice and Future Possibilities_

It is probable that, in the fulness of time, the present will be looked upon as the period in which rotating-wing aircraft "grew up." As other sections of this issue show, development contracts and large-scale production orders are now being placed for a variety of rotary-wing designs, the majority of which are intended to meet specialized operational requirements. Gone, at least, is the perception that the helicopter was only a subject for experiment and "stunt" demonstrations.

Helicopters of sorts have been built, off and on, throughout the lifetime of this journal—say 45 years. For the first 40 of these years, most aircraft piston engines were minute, and nothing like the quantity required to warrant the development of special helicopter engines, designed _ad hoc_ from the start. It is therefore understandable that rotary-wing airframes have in the past been built around engines which, if not quite the cast-offs from fixed-wing practice, have not necessarily been what the helicopter designer would have chosen had he had a free hand from the outset.

The propulsion of helicopters is a truly vast field. The terms of reference for a writer on rotary-wing power units cannot stop at "an engine" as such, for the choice of power unit is intimately related to the purpose of the aircraft, which determines the rotor-system employed and the type of power required. In fact, it is possible to employ a propulsive system extending throughout the aircraft, without any single item which could be called the engine.

As we have said, rotary-wing aircraft are in an adolescent stage. Anyone who doubts this should try to assign an operational class or purpose to most of the designs now flying in service; inevitably the answer has to be "miscellaneous," just as it was on fixed-wing aircraft before World War I. In every case the designer was originally concerned solely with the development of a successful flying machine, and those designs which have been adopted in all the earliest production helicopters, is a single lift-propulsion arrangement, typically a horizontally-mounted close underneath the hub of the rotor. The latter is a disc area, and other factors, but it will rarely exceed about 300 r.p.m. A step-down gearbox between the engine and rotor is, therefore, a necessity, and it can be mounted either on the front of the engine crankcase as in fixed-wing practice, or it can be mounted close underneath the hub of the rotor. The latter is a better arrangement, since it allows a simpler and more easily changed engine to be used, and also permits the use of a lighter drive shaft, owing to the higher r.p.m. and hence lower torque.

The classical configuration is still much used, and serves well to introduce a description of present helicopter piston engines and shaft-drives, which must be taken as a starting point before considering the radically different systems of the future.

British Leonides are found in foreign helicopter engines, such as the American Pratt and Whitney, Franklin, Lycoming and Wright, and the French Salson and SNECMA 14X-H. All these engines are highly-developed and they are proving adequate for their present tasks. But all suffer, to greater or lesser extent, from the omnipresent problem—their fixed-wing heritage. As far as power requirements are concerned one of the most fundamental differences between fixed- and rotary-wing aircraft is that, whereas a fixed-wing aircual calls for a great effort for a short time (at take-off) followed by lengthy cruising at moderate powers, the helicopter is less concerned with short-time all-out power than with steady output at perhaps 90 per cent of the maximum possible. Although it is not intended to constitute a precise picture, completely redesigned with the sump on what was formerly the rear cover. Accessories, too, are in quite different positions from those in the "fixed-wing" Leonides; in fact, it is often advantageous to mount the major aircraft-system accessories on the rotor gearbox, where they remain operative in the event of engine failure.

The engine mounting for vertical-crankshaft engines usually consists of a built-up ring assembly attached to the crankcase, supported upon a welded steel-tube mounting carried by locally strengthened portions of the fuselage. Vibration-damping, exhaust systems, fire prevention, and similar subjects generally follow fixed-wing practice. Cooling, however, is particularly important, owing to the very low air-speed at which the engine may be required to give full power. In the Leonides, which can be taken as quite representative, the whole engine is closely cowled in an unstressed light-gauge sheet assembly, through which cooling air is forced in a downward direction by a fan. The cooling air enters at the top of the fuselage, ahead of the rotor hub, and passes out to atmosphere below and to the rear of the engine. The fan itself is driven at crankshaft speed, and is a flexible coupling connected by light-alloy bolts to a flange on the engine shaft.

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