weights. As soon as the pressure is removed the blades take up the high-pitch position and the oil in the cylinder is returned to the crankcase under the pull of the counterweights.

More recently the Hamilton and De Havilland concerns have built large numbers of constant-speed airscrews. These are similar to the two-pitch type, but embody a device by means of which the load on the engine is varied automatically by the airscrew, maintaining a constant speed and power output over a wide range of conditions, irrespective of the attitude of the aircraft in flight. This device may be likened to an infinitely variable gear box. An over-ride control enables the pilot to obtain maximum efficiency at all times. Advantages claimed for the constant-speed unit are fuel economy, reduction in engine wear and relief for the pilot. Briefly, the automatic control unit consists of a gear-type pump fed by oil from the engine and delivering to the airscrew a constant pressure of about 200 lb. per sq. in. Two engine-driven flyweights operate a piston valve admitting and releasing oil to or from the cylinder.

The very latest Hamilton development—and one which has been quickly taken up by the De Havilland concern—is the Hydromatic airscrew. This has been introduced to meet the demands for airscrew pitch ranges created by modern military types and by the increased speed ranges and ceilings of new commercial aircraft. It is capable of being fully feathered, *i.e.*, the chord of the blades may be set almost parallel to the line of flight—a factor of some importance in multi-engined aircraft should one power unit fail. The hub and blade mounting structure is similar to that used on previous Hamilton airscrews, but has been improved in a few respects.

Even after the two-position Hamilton had been put into general service in America many technicians still regarded the device with little enthusiasm. In *Flight* of June 6, 1935, one finds a volume of correspondence from designers discussing the relative merits of variable-pitch airscrews, two-speed reduction gears and high ground boosting for take-off. By that time it was generally agreed that the v.p. airscrew had come to stay. One of the earliest manifestations of the capabilities of the "v.p. prop." was the success of the De Havilland Comet long-distance racing machine powered by two 225 h.p. Gipsy Six engines fitted with v.p. airscrews. This machine was able to lift over the screen a total load of 5,550 lb.—at least, 1,000 lb. more than could have been handled with fixed-pitch airscrews.

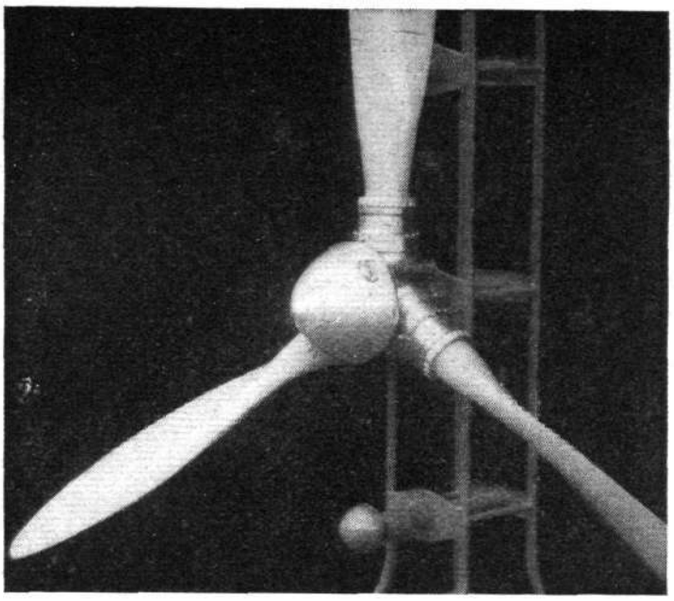
Early V.P. Limitations

The Comet was originally fitted with French Ratier airscrews, the De Havilland Company at that time not being in production with a suitable airscrew of their own. This model of the Ratier did not permit full control of the pitch during flight. The pilot could change from fine to coarse pitch whenever he wished, but when once set to coarse position it was not possible to change back to fine. Overshooting on a landing was, in consequence, distinctly unpleasant, due to the slow acceleration.

Since that date the Ratier company has developed a number of outstandingly interesting airscrews. One has been evolved for use with the French *moteurs canon* and provides for small explosive shells to be fired through the airscrew hub. The secret is a small windmill operating the pitch-changing mechanism; when the speed of the windmill drops below the airscrew speed the pitch changes into the fine position and vice versa. Thus on climb the pitch changes down, and in level flight makes the reverse movement.

The simple windmill system of operation is also employed for the new Argus airscrew.

A type which seems destined for a useful future, not only in America, but in this country (the licence having been secured by Rotol) is the electrically operated fully feathering Curtiss. An outstanding advantage of the electrically operated type is the ability to be used either as a constant-speed or a selective manually controlled type in the same installation. The manual control allows any blade angle between the low-pitch limit and the feathered angle to be obtained and maintained independently of engine conditions. Pitch change is effected by a small series-wound reversible direct-current electric motor, operating through a two-stage planetary speed-reduction unit to a bevel power gear which engages a bevel gear fixed to the root of each blade.



An example of the latest type of Fairey variable-pitch airscrew, preliminary details of which are given in the accompanying article.

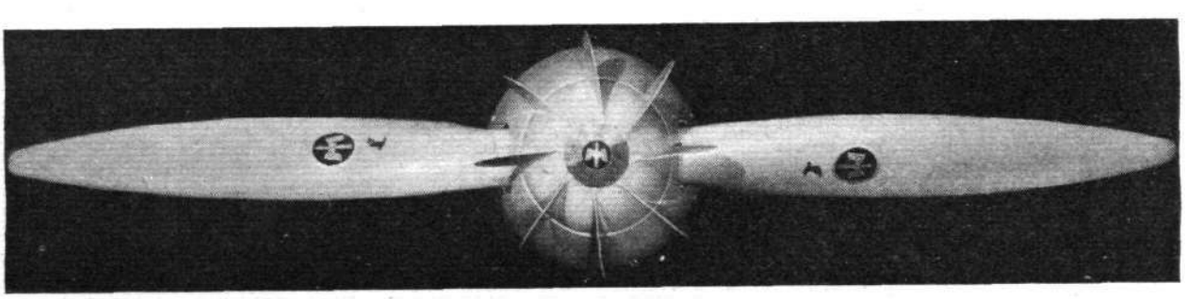
Electrical operation is also employed on the German V.D.M. design; this likewise is capable of being fully feathered.

Although the Rotol concern has the licence for the electrically operated Curtiss, and will, in fact, shortly be producing airscrews of this type, the company sets great store by the hydraulically operated units of its own design. Fully feathering and non-feathering designs are available; in either case the airscrew comprises essentially an hydraulic cylinder to which the blades are connected by operating pins or links and a fixed piston carried on a sleeve member extending through the cylinder. Pressure oil from the engine, controlled by an engine-driven governor unit, actuates the cylinder and varies the pitch of the blades.

Apart from the Rotols, we have under development in this country a number of Fairey variable-pitch designs. A typical unit for an engine of 1,000/1,200 h.p. (12ft. 6in. in diameter) weighs 360 lb. with duralumin blades; 320 lb. with magnesium blades and 300 lb. with wooden blades. The blades have a range of 360 deg. Minimum and maximum positions are controlled by stops which can be reset without removing the airscrew from the engine. Attractive characteristics are the main operating unit, which can be used for airscrews of engines from 700 h.p. to 1,200 h.p.; the ability to remove the blades complete with their bearings as units; and the fact that the airscrew can be assembled by one mechanic and an assistant without the use of special tools or equipment in about three hours.

The French Gnome-Rhône airscrew is of interest chiefly because it employs compressed air. To adjust the pitch the pilot operates a lever and admits air through a valve, driving a piston and moving the airscrew blades. When the desired pitch is reached the lever is released and the pneumatic drive immediately cut off. The makers emphasise that the pilot's movements should be carried out in a decided manner and without hesitation; he might be tempted, they explain, to reach the best pitch by tentative moves or to operate the controls by jerky touches which would be unfavourable to the proper mechanical working of the airscrew.

Although constant speed is generally associated with the larger types of airscrew this feature is now available for the private owner of even the smallest aircraft types. The airscrew concerned is the strikingly unorthodox single-blade American



A system of vanes is used to control the pitch on a new type of Argus airscrew developed in Germany.