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U.S. AIR SERVICES
Dependability in Propellers
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EDITOR'S NOTE. - The author of the following article is the subject of the cover photo-graph this month. After a distinguished career in the Army Air Corps Major Walsh is devoting his abilities to the importance of dependability in propellers for Aircraft.

THE element which stands by itself in importance in propeller manufacture is dependability. The virtue must be possessed in the highest degree by not only each different design of propeller, but the processes of manufacture must be so controlled as to reproduce this quality unimpaired in each and every propeller manufactured to these designs on a production basis.

This dependability is secured only by careful designing resulting in the most intelligent compromise between conflicting requirements of strength and lightness. Correct theory alone is not sufficient--extensive practical experience is also required, as is well illustrated by the fact that in certain instances what are now recognized as defects in early designs remained undiscovered until after two or three years' flight service.

Although pilots today give very little thought to their propellers, it takes only a remote possibility of failure to make their concern acute. No propeller about which there is question as to its dependability can possibly succeed, no matter what other merits of efficiency, lightness, or cheapness it may possess. The enlightened self-interest of the manufacturer dictates that all new types of propellers receive exhaustive test before placing them on the market. The position of the manufacturer who acted too hastily and sold some hundreds of propellers before hidden defects appeared after say 1,000 hours of flight service, would be most unenviable. The position of an airplane manufacturer who had standardized on an inadequately tested propeller would be equally bad.

Considering the rigorous schedule of tests which are now considered necessary for all new propeller developments, one is impressed with the faith and optimism of the pioneering efforts which made available to the world the present standard types of light alloy metal propellers.

In the case of the old wooden types of propellers, a whirl test only, and to only 50% overload, was considered ample. During the early history of the metal propeller the overload requirements were increased to 100%, but engine tests were few indeed.

Today the whirl test is only one part of the story and yet it has advanced to the point where new types of propellers are required to withstand 300% of their normal power rating on whirl test in order to be considered satisfactory. The art of propeller design has so far advanced that few propellers designed by competent engineers fail on whirl test.

In our own experience, the first propeller manufactured to an entirely new design and involving a new blade material, withstood over 600% overhead on whirl test.

PRESENT thought is that whirl tests adequately test the outer parts of the blade as regard strength to resist the centrifugal and bending stresses, and serve as a check on any tendency to "flutter" as the result of improper design. It is now recognized, however, that the inner portions of the blade are not checked by the whirl test sufficiently to insure safety under all conditions of flight operation. The hammer-like impulses from an internal combustion motor set up destructive vibrations possibly leading to fatigue failures, which are not duplicated in the whirl test. For this reason, it is now common practice to give all new designs an engine test of approximately 50 hours at full power rating. Since this test is normally run on a more special stand which is very much more rigid than the airplane engine mount, a successful passing of both the whirl and engine tests enables the propeller to be put into flight service with every confidence.

To secure the advantages of propeller engine tests more economically and under conditions permitting better control, we have recently designed and installed a special machine to simulate and accentuate these destructive power impulses on test propellers. Calibration tests of this machine will be under way shortly and we hope to be able soon to secure data which will result in still greater propeller dependability.

Early in the year we found out that a considerable number of our present standard type propellers had been flown for more than 2,500 hours in commercial service. Through the cooperation of the transport operators and the Material Division at Wright Field, exhaustive tests are being made on three or four of these propellers to ascertain whether or not there had been any loss in strength due to this long use. While the tests are as yet incomplete, the results so far have indicated no loss in strength. All of these propellers have successfully passed a 10-hour whirl test at 300% of their normal power rating.

While we are on this subject, it is proper to call attention to the fact that the safe life of a propeller is largely beyond the control of the propeller manufacturer. Severe conditions of operation, faulty maintenance of either motor or propeller, and many other things, may make the safe life of the propeller read in hundreds rather than in thousands of hours. This point is well illustrated in a letter which we received in connection with a propeller which had been sent in for repair recently. Our attention was invited to the fact that one blade of the propeller had a little "nick" about 8 inches from the end. The letter went on to state that in order to balance the propeller the owner had cut a similar "nick" in the other blade, and we were requested not to repair the "nicks" when we straightened the propeller, since it was performing very efficiently. In this case the owner had entirely ignored the very grave possibility of fatigue failure starting at the base of a fairly deep and sharp nick, and had even doubled the risk which he was taking by seriously weakening the other blade.

It will probably be of general interest to know that there is no record of a propeller having failed as a result of the straightening of a bent blade where the