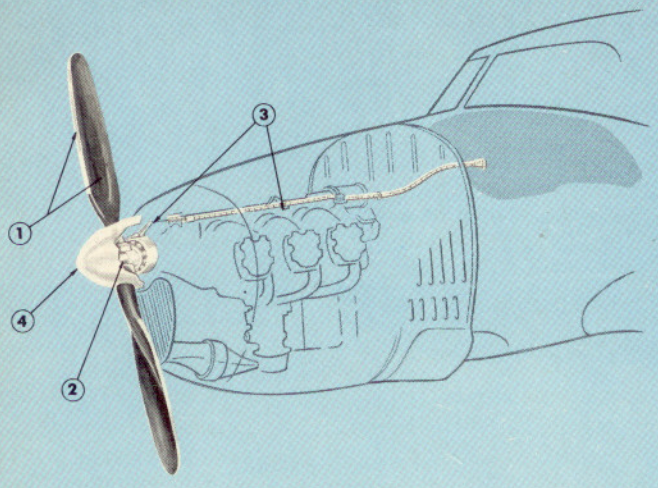


PROP CHECKS

1. Check for cracks, notches in metal propellers or lamination separation in wood. Loose rivets and creepage of metal tipping on wood props are danger signs
2. Hub should be checked for cracks, oil leakage or corrosion, proper installation and fit
3. Propeller control system components should be checked for chafing, security of attachment, condition of wiring
4. Cracks and chafing of the spinner, security of its mounting should have attention

Care For Your Propeller

Five propeller manufacturers warn that neglect can be dangerous and costly, but early treatment of trouble signs can prevent serious propeller damage

A pilot we know nearly had a mid-air shave the other day when a chunk of his propeller broke off while he was shooting landings. He was at 300 feet when it happened, but luckily landed safely in an open field. He exited from this incident with a mechanic's bill in the neighborhood of $600—for bent motor mounts, ripped oil sump, heater hoses, new prop, and so forth.

Of course, he was outraged—outrage compounded by knowing he had flown the airplane only 20 hours since its periodic inspection. In general appearance, the propeller had seemed all right, he said, but shouldn't an authorized inspector have been able to tell him it wasn't?

The obvious answer is of course, "yes," somebody at sometime should have been able to point to danger signs. While you can't predict when a piece of hardware will fail, you usually get a warning. After that, catastrophe may be quick. Unfortunately part of the danger is the reluctance people may have to admit that dubious signs of trouble are worth troubling about.

Last year, the Bureau of Standards ran tests on a number of lightplane forged aluminum alloy propellers that had failed in flight. Metallurgical studies showed that all of the fatigue fractures on these blades started at a dent on the leading edge, then progressed back toward the trailing edge. They found no differences in composition between failed and unfailed blades or significant differences in tensile strength and hardness that might have had a bearing on fatigue failure.

To get some professional views on propeller problems, The PILOT asked several manufacturers what, if anything, the ordinary owner should know about his propeller and how seriously he should take the old cliche he learned as a student, "look for nicks and scratches." Their reports follow:

Sensenich Corporation

It is not expected that the pilot or plane owner be familiar with propeller maintenance. However, a bit of knowledge relative to propellers and blades is desirable so that maximum safe use may be obtained with minimum care.

The propeller is the most highly stressed item on the aircraft, yet it is probably also the most abused. Some of the abuse is due to natural vulnerability and some to lack of operational knowledge. The fact that the safety angle is often overlooked is surely due to lack of understanding, yet both abuse and lack of understanding can be overcome.

The most common blade damage comes from nicks, gouges, scratches, water and sand abrasion. Water and sand abrasion, giving a sand blast appearance, may be considered normal wear. Small nicks, 1/64th (.015) deep, may be considered normal on most propeller-engine combinations, but must be removed on others.

There are too main "don'ts" we want to establish. Don't permit your propellers to get full of deep nicks and scratches and don't accumulate flying hours when they are nicked (1/16th to 1/8th inches deep).

In some cases the first taboo can't be avoided, but the second certainly can be. From a safety standpoint, nicks in the area between 3.5 inches and 18 inches inboard from the extreme tip are considered the most dangerous.

Most fixed pitch metal propellers

and metal propeller blades are made of an aluminum alloy. We speak of this material as having a certain "service life." By service life we mean the number of bending cycles or flexings the blade can stand before it fractures and failure occurs. The amount of flexing the blade can tolerate on the current single and light-twin engine aircraft is so great that the material is considered to have an unlimited service life. If this were not so, a service life of a certain amount of hours could be accumulated, at which time the blades would have to be retired from service.

However, the service life is unlimited only with the material in undamaged condition. A nick is often referred to as a stress raiser. Or, it may be called a point of concentrated stress. The stresses of the blade flexing will concentrate at a point of damage. This means that flying the aircraft, with a blade in nicked condition will use up the blade service life at an accelerated pace.

This you can prove to yourself by bending a piece of wire back and forth until it fails. You are testing the service life. Next, nick the wire and bend it again until it fails. You will find the service life was used up faster when the wire was nicked and it failed prematurely.

Let's say a new blade has 100% of its service life ahead of it. A fairly deep nick is inflicted but is immediately removed and polished in the proper manner. The material still has nearly 100% of its service life left. Let's now say we neglected the nick and the aircraft accumulated flying hours to a point where 50% of the service life was used up at an accelerated pace. If the nick is then removed, the rate at which the service life was being used up goes about back to normal, but, kiss good-bye to the 50% used up. It's gone forever.

Service life cannot be built back into the material. Therefore, the service life of the blade is directly related to the maintenance care received.

Now a few words about functional problems. There are so many little problems that an alert pilot can prevent from becoming big ones:

The propeller may gradually reduce its rate of pitch change; it may become rough; gradually, there may develop an abnormal amount of blade rotational play or blade end play. You may notice reduction in rate of feathering or failure to feather entirely, automatic unfeathering inoperative or the start of feathering before controls are in the feathering position. There may be a surge on takeoff or during normal cruise. It may not develop takeoff r.p.m. or develop takeoff r.p.m. only after reaching climbing speed. Propellers may not stay synchronized during cruise, landing approach or during low-speed IFR holding pattern. Propeller controls may not be even on twins during cruise or climb. There may be oil and grease leaks.

With a few exceptions, the above may be more annoying than really serious and most can be remedied with a few adjustments or minor maintenance work. The important thing is that any one of them could be, and should be considered, a warning that a dangerous condition is in the making.

If you are confronted with any of the problems and symptoms related here, you should immediately contact a propeller service agency, whether a manufacturer or approved propeller repair station. In any event, it should be an agency that specializes in propeller and governor work. In contacting a propeller agency be prepared to give an accurate description of both the trouble you are encountering and the equipment being flown, make and if possible, model. A good propeller man, with a good description of the symptoms, can probably diagnose your trouble and determine how serious it may be.

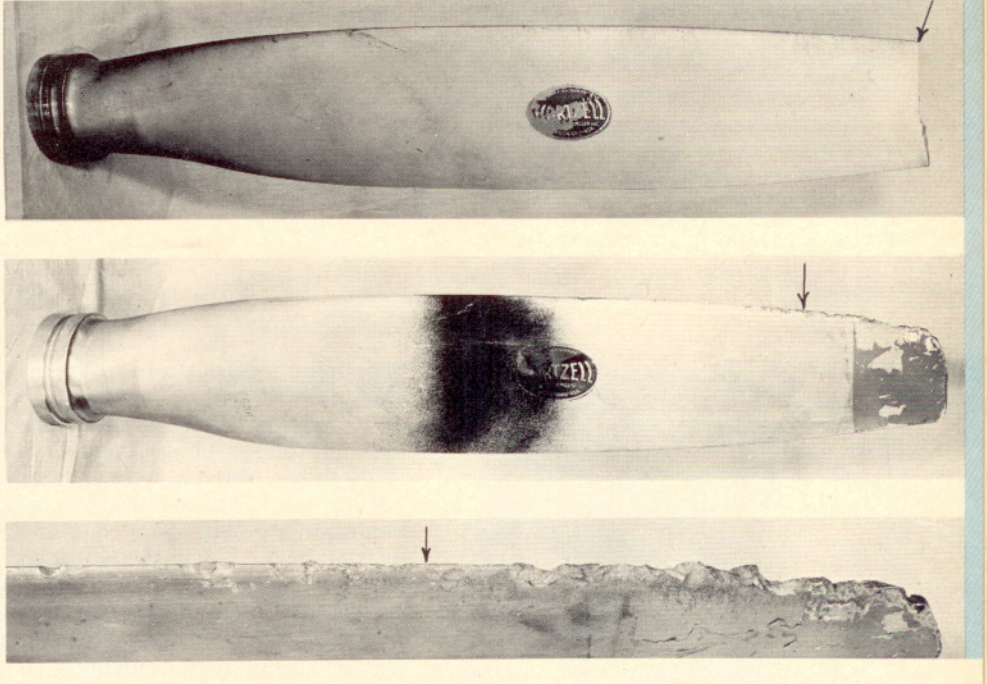
Finally, preflight propellers. Avoid flying with blades in badly nicked condition as religiously as you avoid water in fuel. Just because low-horsepower four-cylinder engines tolerated severe nicks, don't be lulled into false security regarding the tolerance of higher horsepower engines for severe nicks. They don't have it.

In this connection, the writer has inspected more than 20 blade tip failures covering a wide variety of aircraft - engine - propeller combinations. When in doubt, contact your propeller man. He's probably seen your problem before!—*H. M. ENCK, Service Manager.*

Hamilton Standard Division, United Aircraft Corporation

With the benefits to be obtained from proper maintenance, it seems illogical that some isolated operators choose any other course. Our general

(Continued on page 56)



Bureau of Standards tests on these propeller blades showed that fatigue cracks were not caused by pre-service defects or surface discontinuities but were started by dents on the leading edge. Upper photo shows propeller broken at most common fracture point. Arrow on unbroken blade indicates location of breaks on blades that failed. Lower photo is an enlargement of the leading edge near the tip with arrow pointing to point of possible fracture

Propeller Care

(Continued from page 35)

comments apply to all propeller types from fixed pitch up through modern airlines equipment providing constant speed action, full feathering and reversing. Only in the operational checking of propellers will procedures differ from model to model.

Propeller system maintenance is normally broken down in the following categories—that accomplished before and after each flight; that accomplished at periodic intervals less than normal overhaul; and that accomplished at overhaul. Experience over considerable time has shown this classification of maintenance to be effective.

At pre- and postflight inspections, close visual inspection should be made of the propeller system. Particular attention must be given propeller blade surfaces for evidence of nicks, cracks, raised edges, gouges, bending, corrosion or erosion. All blades should be cleaned so that a thorough visual examination can be made.

The propeller blade is a major structural member and damage can result in significant loss of strength. In addition, the propeller and governor assembly should be inspected for evidence of damage, security of mounting, excessive oil leakage or any other abnormal conditions. Very real benefits are realized in conscientiously carrying out these inspections and they should not be short circuited. When damage is found it should be immediately repaired in accordance with the applicable service publications.

During engine checkout prior to takeoff, operation of the propeller system should be checked to determine if it is properly controlling engine r.p.m. We generally recommend that the crew set the engine and propeller controls at some intermediate r.p.m. When the engine throttle is then moved back and forth over a limited range, the engine r.p.m. should not change.

On moving (or toggling) the propeller control back and forth, the engine r.p.m. should rapidly follow the action of the propeller control. When the feather button is depressed, the engine r.p.m. should immediately decrease and, with the return of the button to neutral, the r.p.m. should immediately increase to its originally set value. As a check, the button is usually manually returned to neutral before the propeller is fully feathered to prevent complete stoppage of the engine.

On moving the engine controls into reverse, the propeller should rapidly reverse. On moving the engine controls out of reverse, the propeller must rapidly unreverse and automatically terminate the unreversing action several degrees above the propeller low-pitch stops. With full takeoff power applied and the propeller control moved to maximum r.p.m., the propeller should control the engine at takeoff r.p.m. It is to be pointed out that under some conditions, the engine may not be developing enough power to produce takeoff power and r.p.m. against the blocks. This should be recognized as such and not attributed to improper setting of the propeller or governor. Any sluggish or erratic operation of the propeller in the performance of the above checks should be immediately investigated.

The above visiual inspections and operational checks when applicable for your equipment should be routinely made each time the aircraft is used. For a periodic check, that is, one performed at intervals less than normal overhaul, the propeller should be examined for excessive engine sludge accumulations in the dome assembly, and, when found, these accumulations should be completely removed. Instances have been encountered where excessive sludge has produced sluggish propeller operation and inadvertent reversing immediately following unreversing. This accumulation is based on many factors—type of engine, oil type, environment, operation procedures, and so forth—so that it is very difficult for anyone other than the individual operator to determine an appropriate periodic check period. The periodic check should also include the visual inspections of the pre- and postflight inspections.

Complete and thorough overhaul, in accordance with applicable service publications should be carried out at regular intervals. These intervals are again best established by the individual operator based on his prior experience or the experience of another operator of identical equipment. It is very difficult for us to prescribe this time period since there are many variables involved over which we do not have direct control or knowledge. Considerations such as engine condition, operating performance and conditions, maintenance standards, etc., all enter into the establishment of an overhaul period. For convenience, however, the period is usually selected to coincide with engine overhaul periods. There is one overriding consideration, indeed, that the overhaul period should never be allowed to extend beyond an 18 month calendar period. This is necessary to insure that there is no extensive corrosion or nonmetallic part deterioration because of extended periods of non-use or storage under questionable conditions.

It has been our intention here to outline in broad terms certain important procedures which should be followed by every operator. The above procedures and others of more restrictive application are covered in full detail in service manuals and bulletins which have been issued though the years. We would recommend that the operator make certain he has in his possession all publications applicable to his equipment. An inquiry to the attention of the Supervisor of Service Publications, Hamilton Standard, Windsor Locks, Conn., will produce a complete listing of available maintenance and overhaul information on our propellers. We are confident that other manufacturers will provide comparable service. With the careful and conscientious accomplishment of the maintenance procedures spelled out in such bulletins, efficient

and economical propeller system performance will be the operator's reward.—*W. H. FURNIVALL, Supervisor, Service Engineering.*

Hartzell Propeller, Inc..

The propeller is one of the most vital parts of an airplane, and malfunction can result in serious consequences. It is subjected to extremely high centrifugal forces, bending moments due to thrust and torque, and vibratory forces which are fed into it from the reciprocating engine. It is therefore most important that it be inspected. The following preflight checks are recommended:

Blades. Nicks or stone bruises in the leading edge of blades near the tips could result in a crack if the vibratory stresses are unusually high. It is important to dress out these nicks immediately after they occur. Cracks have been known to start within three hours flying time after the blade was severely notched with a rock. Small nicks may take longer to generate a crack, but the potential is there nonetheless.

In dressing out a nick, it is important to get below the damage of the metal and to dish out the damaged area gradually. Smooth up with fine emery paper.

Spinners. Spinners are also subject to fatigue cracks, so they should be watched closely. Cracks can start from nicks or chafing between two parts or from sharp corners. It is important that the spinner not rub against the blade shank, or hub parts, as chafing often results in a crack. This can be extremely hazardous, if the blade root is notched by the rubbing of a spinner.

Controllable Pitch Hubs. Rust or corrosion should not be allowed on the outside or inside of a propeller hub as these are also possible causes of fatigue cracks. Keep the inside of the propeller well greased. Hubs should also be inspected for cracks periodically, particularly during the 100-hour inspection.

Operation. Propellers should be exercised during engine warm up to insure proper operation and to circulate the cold oil.

Control System. Propeller or governor control wires or lever systems often wear at certain points which may result in control failure.—*DAVID BIERMANN, Vice President and General Manager.*

McCauley Industrial Corporation, Aircraft Division

We would urge pilots to regard the following items as important for proper propeller care:

Be aware of flight manual section pertaining to the propeller. This information should be given precedence over any preconceived ideas. For constant speed and feathering propeller models, the propeller manufacturer provides an owners' manual on maintenance, operation, design and construction. He's an

expert, so know what he recommends.

Inspect propeller before each flight. Especially check the outboard sections of the blade from tip to approximately 12 inches inboard. Do not ignore any noticeable blade damage occurring from stone or rock impact.

Inspect the spinner external surfaces. Be on the lookout for signs of grease or oil leakage, for loose screws and for lockwire condition.

Wipe propeller blades off with an oily rag occasionally, especially for seaplane operation.

Check propeller mounting bolts and nuts for proper torque at every 100 hours, or at least every quarter to catch seasonal variations.

Other external hardware on propeller and spinner should be checked for tightness.

Never permit high speed operation of propeller over dirt, gravel, or stony areas. Even when taking off from areas of this type, it may be best not to apply full throttle until airspeed picks up.

Never use the propeller blades as handling grips to move the aircraft back and forth. — *W. B. VOISARD, Vice President-Engineering.*

Beech Aircraft Corporation

Based on our observations of propeller abuse, we would list in order of their importance a number of warnings:

(1) Pushing or pulling on the propeller blades outboard of the shank should never be used as a means of moving the aircraft (the shank is the blade area next to the propeller hub). Pushing or pulling on the propeller blades will bend them out of track, necessitating a major repair to straighten them. Also, the propeller blades may bend in an area which is not repairable, resulting in a costly replacement.

We highly recommend the use of a tow bar. If a tow bar is not available and the propeller is used in moving the aircraft, grasp the blades at the shank.

(2) Nicks, dents and scratches in metal propeller blades should be removed as soon as they are found during the postflight inspection. This repair should be accomplished by a competent mechanic who is familiar with the blade repair tolerances and procedure. The propeller blades will flex when the propeller is rotating, with the result that sharp corners in the nick, dent or scratch may start a crack and result in a blade failure. In addition, the stresses are high on metal propeller blades and a blade failure is encouraged by unattended damage.

(3) Polished aluminum propeller blades are not recommended by Beech Aircraft Corporation. The polishing operation requires the use of a high speed buffing wheel to attain a high luster and the resulting friction will cause a thin hardened surface. This hardened surface will be filled with many minute hair line cracks which could contribute to a propeller blade failure.—*BEECHCRAFT Commercial Service Section.*