N8489B Gyrocopter

This document specifies the features (mostly related to safety and best construction techniques) implemented on the N8489B Gyrocopter. Further, the document presents a number of comparable gyrocopters which have sold on eBay and elsewhere as well as a more expensive design and a "bargain" machine that is incomplete, in order to justify the asking sales price of $10,000.

The N8489B Gyrocopter was constructed from a Bensen B8M kit purchased by Prof. Robert C. Michelson who was the builder, FAA certified mechanic, and sole owner. Michelson is an engineer with degrees in Electrical Engineering from the Virginia Polytechnic Institute and the Georgia Institute of Technology where he currently serves as Principal Research Engineer Emeritus and was adjunct Associate Professor of Aerospace Engineering within the School of Aerospace Engineering. During his 30 year career with the Georgia Tech Research Institute, he learned the techniques necessary to properly construct his gyrocopter and was aided by having state-of-the-art tools to machine, process, treat, and assemble the parts to aerospace mechanical and electronics standards. N8489B was therefore not built by the average hobbyist.

The N8489B Gyrocopter is being sold "as is" with no warranty and as a "kit" requiring some assembly by the purchaser prior to use. Components assembled by the Bensen Aircraft factory are being sold as units, exactly as they were received originally from the factory.

WARNING: Flying is inherently dangerous and improper assembly or maintenance of the aircraft can lead to failure.

FEATURES

The N8489B Gyrocopter contains features not found on stock (or most custom) gyrocopters. The N8489B Gyrocopter has a custom composite vertical tail structure to dramatically reduce weight. The joy stick is from a UH1 Cobra helicopter and the pilot control buttons have been wired to activate the radio and nose camera. Spare switches are brought out through the connector for future applications. The compass, sensitive altimeter, and air speed indicator are all aircraft quality instruments. Main gear are co-linear with the landing gear strut to eliminate aerodynamic drag. A "seat tank" is used to further eliminate drag and weight. The seat tank has been fitted with a fuel observation tube to allow the pilot to know precisely how much fuel remains. The McCulloch engine has been overhauled to have long life bearings and improved pistons. An expansion chamber acts not only as a muffler and exhaust gas diverter (toward ground and rear), but it provides a degree of two-cycle engine tuning. The wooden prop was chosen for its aesthetic laminated wood pattern, but it also features stainless steel leading edge and tip protectors to prevent foreign objects thrown up from the ground or encountered in flight (birds) to splinter the prop. This B8M design has a dual tube rotor mast for additional strength and flexibility. The Bensen blades and hub have never been disassembled, but are transported as a unit to assure alignment and to eliminate fatigue. They have always been stored hanging flat with tip support. The N8489B Gyrocopter tires have had tubes installed to prevent bead separation blow-out were a hard landing to take place. A tail wheel with a shock absorber has been custom milled for this aircraft in order to reduce lading fatigue. An aircraft transceiver (triggered by the pilot from the joy stick) has been installed along with a landing gear-mounted antenna. This radio is inadequate (analog tuning) and should be replaced with a modern version that is smaller and lighter.

CONSTRUCTION TECHNIQUES

Care was taken during construction to follow the Bensen B8M construction plans to the letter. All drilled holes in aluminum tubing is done by jig and only through the face of the tube (i.e., through holes are drilled from opposite sides of the tube so as not to score the inner wall of the tube). Only milling machines and drill presses were used to drill holes in order to assure perpendicularity. Where necessary, bolts and nuts are "safety wired" to prevent back-out. Elsewhere, "stop nuts" are used. Many large flat surfaces are riveted to prevent loosening with vibration. In all critical locations, hardness 7 (or better) bolts are used as are MIL Spec aircraft hardware. Electrical connectors are premium grade or MIL Spec. Painted surfaces are OD-Green MIL Spec. zinc chromate aircraft quality paint, or for hot surfaces, high temperature flat black is used. To prevent corrosion, engine mounts and certain other aluminum parts have been black anodized (however a few are clear anodized). MIL Spec shock absorbers are used on sensitive aircraft instruments to protect them from vibration. Redundancy has been built in to many systems for reliability and safety. For example, dual (parallel) fuel pumps and two stages of fuel filtering are used. Engine parameters monitored are: cylinder head temperature, fuel pressure, fuel level, and RPM (RPM gauge and sender are installed, but electronics has been removed as a weight saving because RPM was found to be not a critical parameter). For safety, a hot magneto is indicated by a sonalert audible tone and two engine kill switches are provided to allow the pilot to kill the magneto (and engine) from a starting position as well as a seated piloting position. The kill switches have positive locks requiring a double action by the pilot in order to activate them so that no accidental engine shut down can occur.

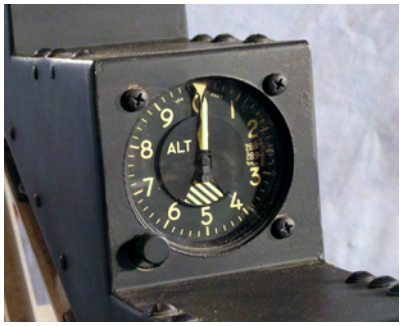
WHAT IS SUPPLIED

Bensen B8M Gyrocopter fuselage components including landing gear, tail and horizontal stabilizer surfaces, pilot seat and restraint system, fuel tank/pumps/filters, engine, prop, engine monitoring systems, attitude/altitude/speed and navigation systems, various safety systems, piloting controls, rotor blades and hub, and all other components necessary for flight. In addition, some spare parts will be supplied including one (1) extra composite vertical stabilizer panel, tow hitch, magnetic timing wheel, spare 6061-T6 cheek plates, and all engineering drawings for the basic B8M. A copy of the aircraft log will be supplied to show all maintenance performed and upgrades implemented. Periodic FAA certifications are indicated in this log.

INSTRUMENTS AND INDICATORS

Magnetic Compass

Instrument panel uses only aluminum and non-magnetic hardware to avoid magnetic influence.



Sensitive Altimeter

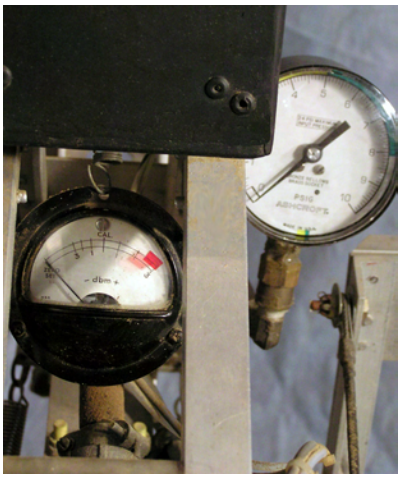
The sensitive barometric altimeter has its sensing input placed at a neutral pressure point.

Air Speed Indicator

A nose-mounted pitot tube supplies input with the static port placed at a neutral pressure point.

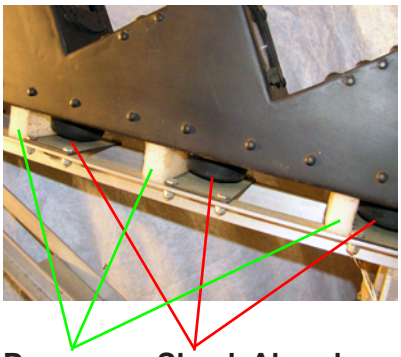
INSTRUMENTS AND INDICATORS (continued)

Cylinder head temperature is monitored on a D'arsonval movement meter (left) while the fuel pressure at the engine is monitored by a Bourdon gauge (right).

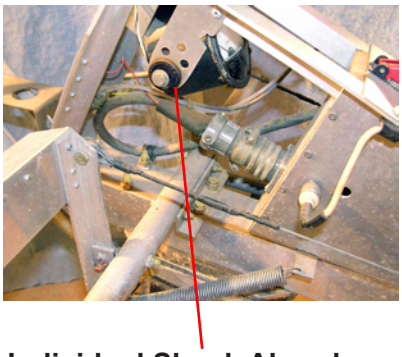


Cylinder Head Temperature **Fuel Pressure**

The entire instrument cluster is shock mounted with MIL Spec. absorbers and tuned with closed cell foam dampeners in order isolate the cluster from any airframe vibration the might lead to fatigue or decalibration of the instrument (see below). Other instruments such as the cylinder head temperature meter are individually shock mounted in custom fixtures. (see below).



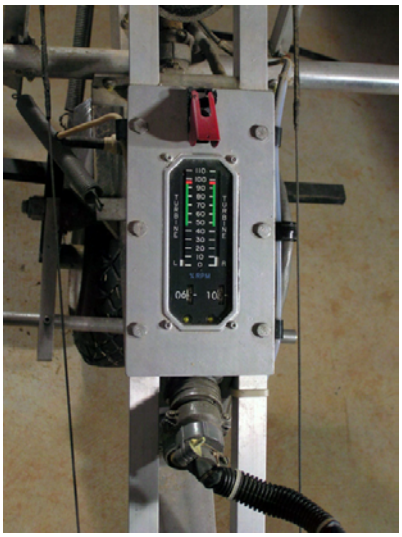
Dampers **Shock Absorbers**



Individual Shock Absorbers

Fuel quantity is monitored from the seat tank by a direct-reading fuel level tube running up the side of the tank in a protective milled titanium tube (see below).

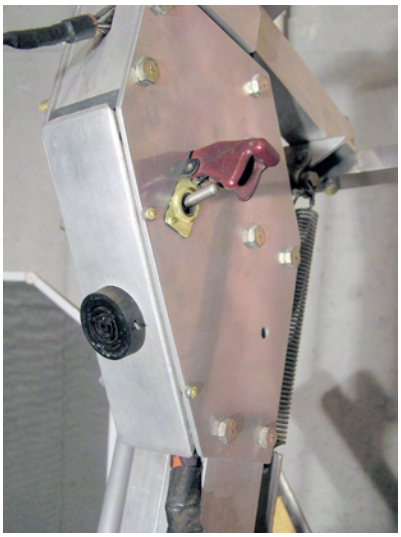
Originally, an engine tachometer was used to monitor the RPM of the McCulloch flat-four engine. A tape-reading indicator removed from a Cessna Citation business jet was adapted to indicate engine RPM from a magnetic sender located over the magneto. Later it was determined that engine RPM could be reliably monitored via engine sound and the weight of the tachometer electronics and battery were eliminated. The tape-reading indicator was left on the gyro as was the magnetic pick-up because they did not contribute significantly to the gross takeoff weight and the option of using the indicator for other purposes was retained. Presently the tachometer function is unavailable. Note from the tachometer photograph that an engine kill switch with a positive double-action lock is located just above the tachometer and within the reach of the seated pilot. A second switch with a similar safety lock (which prevents accidental engine start or shut-off) is located on the rotor



Cessna Citation Tape Tachometer
(engine kill switch above)

Fuel Level Indicator Tube

mast cheek plate so that the pilot can quickly enable or disable the magneto (making the engine startable or killing the engine) during the hand-start process.



This gyro relies on "hand propping" to start the engine. The rotor is also spun up initially by hand rather than using a pre-rotator in order to eliminate the dead weight of such a starter once airborne.

As a safety feature, a solid state sonalert beeps as long as a the magneto is "hot" to indicated that the engine could start. This sonalert can be seen on the front of the cheek plate assembly.

PILOT GROUND AND FLIGHT CONTROL

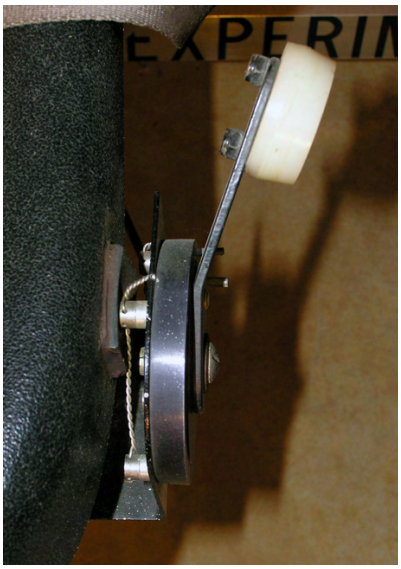
The N8489B Gyrocopter is controlled primarily by a joy stick which varies the rotor disk angle in pitch and roll. A MIL Spec. joy stick removed from a UH1 Cobra helicopter has been installed on this gyrocopter. The forefinger switch is the radio push-to-talk (PTT) control while the central side thumb switch is wired into a nose camera mount. Two other switches are brought out through the connector and are available for future applications. As with many other components of the N8489B Gyrocopter, the UH1 Cobra joy stick is an expensive near-impossible-to-get feature. Many of the components used in this gyrocopter are military-grade items.

UH-1 Cobra Joy Stick provides vehicle vector control and four channels of electrical control.

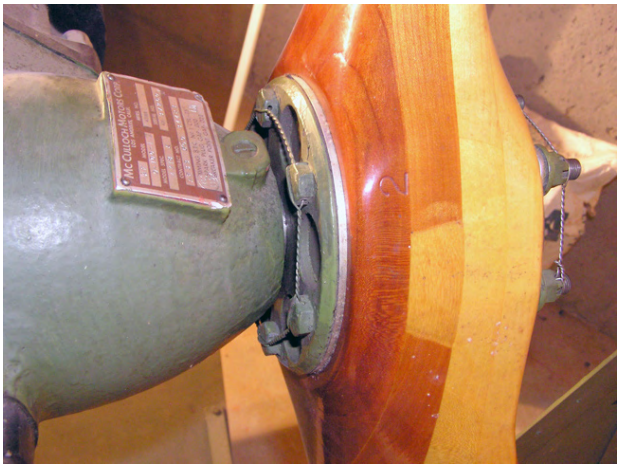
As a safety feature, should the linkage to the rotor head fail (NTSB statistics show that this is an unlikely failure mode, albeit catastrophic), an emergency two-hand rotor head control has been custom machined. This simple overhead control would allow the pilot to safely land the aircraft in the event of such a failure.

Another pilot control is the throttle located on the left side of the seat tank. As seen in the picture below, even the blind throttle attachment screws are safety wired. Safety wire is used extensively throughout the construction of the N8489B Gyrocopter.

Safety wire prevents screws and nuts from backing out or loosening in the presence of airframe vibration. It is used throughout the construction of this gyrocopter as a precaution, not because vibration is a problem. Movies taken from a hard-mounted camera attached directly to the airframe fuselage attest to the lack of engine or rotor vibration in this finely tuned aircraft.



Of particular importance is the securing and correct torquing of bolts on rotating components. As shown in the accompanying picture, the prop hub is completely safety wired on BOTH sides (bolts and nuts, including main crank shaft hub nut) to assure that torque values are maintained. This attention to detail and safety is often overlooked in many home-built aircraft constructed by non-technical people unfamiliar with good engineering practices and safety.



The angle of the vertical stabilizer is controlled via cables from foot pedals which allow the vehicle to "crab" into the wind for cross-wind landings. Unlike a fixed wing airplane, a gyrocopter uses is rotor for "slipping" into a quartering wind, so the fuselage can be maintained in an in-line direction parallel to the runway by applying rudder in the appropriate direction.

Rudder Controls, Steering, and Braking.

Ground control is achieved by way of a steerable nose wheel and heel brake. The rudder is of no use when the vehicle is on its landing gear, so the pilot foot position is on the nose wheel control bars when on the ground, and on the rudder pedal control bars when airborne.

A gyrocopter is a tricycle vehicle during taxi and takeoff, however it is a tail-dragger upon landing. The nose gear control is of no use upon landing until the nose wheel has settled to the ground and the tail wheel is off the ground (the fuselage having rotated about the axis of the main landing gear). Until the nose gear is in firm contact with the ground, the rudder is used to steer.

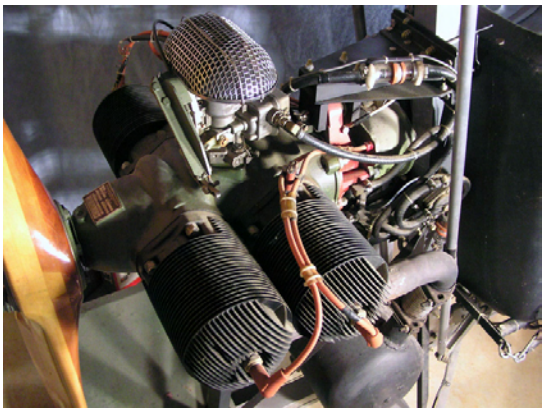
A shock mounted tail wheel has been employed on the N8489B Gyrocopter to reduce landing stress on the airframe. A custom milled tail wheel pivot (see right) acts against an internal shock absorber to eliminate any jolt to the airframe upon touchdown.

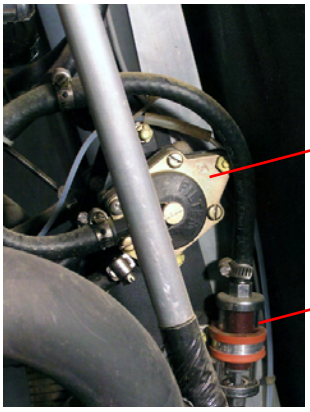
ENGINE AND ACCESSORIES

The N8489B Gyrocopter has a McCulloch "72" flat-four two-stroke drone engine installed. This has been the traditional engine employed on the Bensen B8M design under the designation 4318A. The McCulloch 4-cyl; Model 4318 produces 72hp@4100RPM, and 84@4100RPM. It was manufactured from 1950-1988. Its weight is approximately 77 lbs. These engines were never type-certified by the FAA. McCulloch's aircraft engine business was sold to Northrop-Ventura in 1972. Northrop-Ventura was the successor company to Radioplane Corporation, which built un-manned drone aircraft from about 1940 and owned Righter Manufacturing from May 1945. Northrop-Ventura built these McCulloch engines until the late 1980s.

The drone engines were designed for a short life time based on the assumption that the drones would be shot down. For use in gyrocopters, the short life bearings were replaced with long life units and in some cases, steel sleeves were placed in the cast aluminum "jugs" (air cooled cylinders). Gyrocopter N8489B has the long life engine upgrades making it suitable for manned flight although, like all McCulloch engines, it employs only a single ignition system. The N8489B Gyrocopter engine uses a an automotive carburetor and air filters (see photo) which has been common practice for gyrocopter applications. Ignition wires have been secured to prevent strumming in the wind, and carburetor linkages are likewise secured. Cylinder head temperature is obtained from a thermocouple mounted as a spark plug washer on the hottest (wind-blocked) rear jug to indicate the worst case temperature.

The McCulloch engine uses a vacuum system to drive its fuel pump. For reliability under high density altitude conditions, dual fuel pumps have been installed with separate fuel filters feeding through a "T" into a second stage fuel filter. Were a single fuel pump to fail or a single first stage fuel filter to clog, engine operation could continue. A fuel pressure monitor is available to the pilot so degraded operation can be detected prior to catastrophic engine starvation.

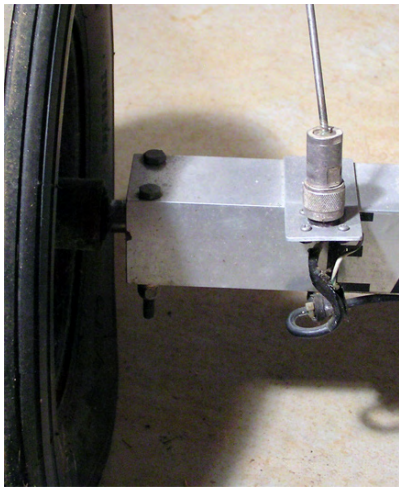




A stock Bensen rotor is used with the N8489B Gyrocopter. It has always been stored and transported in its 22-foot assembled state to maintain perfect alignment and to avoid bolt fatigue. This is an all-aluminum rotor with a solid aluminum hub bar. A special trailer was constructed with an expandible tongue to allow the 22-foot rotor to be transported assembled with the gyrocopter. During extended periods of storage, the rotor has been supported by its hub and at both ends (blade tips) to distribute the weight and prevent any anti-coning angle "set".

OTHER FEATURES OF THE N8489B GYROCOPTER

Most Bensen B8M gyrocopters follow the Bensen plan for main landing gear installation which expediently has the wheel axle external to the main landing gear tube. The N8489B Gyrocopter employs a custom machined internal tube design that puts the axles directly in line with the main landing gear tube to reduce aerodynamic drag and to improve the aesthetics of the machine.

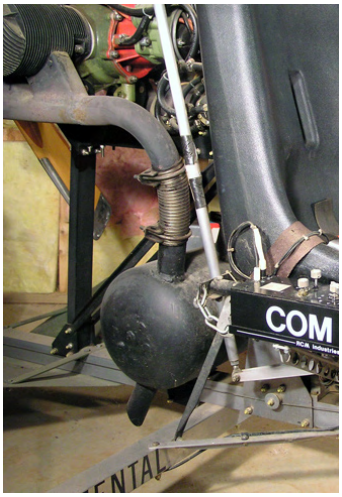


In-line Main Gear Axle

The wooden propeller is correctly sized for use with the Model 4318 McCulloch engine. It is a wood laminate because that is lighter than metal or composite options. Because wood is soft and the propeller is turning around 3000 RPM on takeoff, foreign objects can be drawn into the prop and damage it. This prop has a stainless steel tip and leading edge protector to prevent erosion. A horizontal surface is used on the Bensen B8M design, not for aerodynamic stability, but as a barrier to keep foreign objects from being sucked up from the ground into the prop wash upon takeoff and landing.

Stainless Steel Prop Tip and Leading Edge Protection

The N8489B Gyrocopter has an expansion tank/muffler behind the piloting seat. This helps to tune the two-stroke engine exhaust and further serves to divert exhaust gases down onto the ground below the horizontal surface. Flexible steel exhaust hose allows the expansion tank/muffler to be hard mounted to the airframe while the engine is able to move on its rubber engine mounts. Custom welded exhaust manifolds direct exhaust gas from the engine exhaust ports to the expansion tank/muffler. Even with this muffling effect in place, the engine is loud and pilots should wear hearing protection in the form of earplugs or a helmet with ear phones for radio communication.



A radio transceiver is installed on the right hand side of the piloting seat. This transceiver is capable of receiving and sending aircraft transmissions on Unicom channels. The transceiver was adapted from an old hand-held unit and is not recommended for use because of the difficulty in tuning and alignment (not digitally tuned). It is recommended that this unit be replaced for further flight operations with either a modern digitally tuned hand-held transceiver, or a panel mount unit with digital tuning. Connections are provided for push-to-talk (PTT) control from the joy stick, and power, antenna connection, and earphone ports are removable in order to adapt these functions to a newer radio set.

The original Bensen B8M plans call for a plywood or aluminum vertical tail structure. This is very heavy. The N8489B Gyrocopter has a custom milled aluminum frame with laminated composite interstitial material to eliminate weight while maximizing strength. This light weight structure is approximately 1/16 inch thick where serving as an aerodynamic surface, and 3/16 thick where serving as a structural component.

Structural Webbing **Interstitial Material**

DOCUMENTATION

The N8489B Gyrocopter was granted an "EXPERIMENTAL" rating and passed all of its annual inspections. This is documented in the aircraft log books. These books contain accurate comments about upgrades, modifications, and service performed during the flight life of this vehicle. The aircraft was eventually decommissioned and stored once it was no longer to be flown (a decision based on changing priorities as the owner-builder began a family. The aircraft can be recertified by the FAA and issued a new "N-number" whereupon it will return to service as an experimentally-rated aircraft. During its inactive period, it has always been stored in a climate-controlled area.