MU-2 Landing Gear System

by Rick Wheldon

All of us are familiar with the basics of the MU-2 landing gear system. It is simple yet reliable, and day to day, when properly cared for, we can count on it to operate as advertised. However, like all things mechanical, it can be neglected or mis-rigged, and, when mis-rigged, it can produce undesirable results. Let's go over the basics of the design, and investigate some of the pitfalls to be avoided.

The landing gear systems for both the long and short model MU-2s are strikingly similar to the gear design used in the Lockheed F-104 Starfighter, a 1960s vintage fighter interceptor which was produced in Japan under license by Mitsubishi Heavy Industries. A single electric motor moves the right main gear up and down using a gearbox assembly which in turn drives a worm gear actuator, and the right gear is further connected through torque tubes and a bicycle chain to similar gearboxes for the left main gear and the nose gear (*Fig 1*). The main landing gear doors are actuated electrically. A second set of main gear doors and the nose landing gear doors are mechanically connected to the actuating system. For electrical failures and some mechanical failures, a ratchet type emergency gear actuating system allows emergency extension, but not retraction. The ratchet system takes approximately 120 cycles to release the gear doors and fully extend the gear.

In short model MU-2s, the landing gear retract aft into the gear well behind the rear pressure bulkhead, while long body gear systems retract forward into faired gear wells located beneath the pressure vessel. All of this is controlled electrically with limit switches and a travelling nut/worm gear control assembly under the cabin floorboards. Retraction on the ground is prevented by a safety switch.

When the landing gear switch is selected up in the cockpit after takeoff, the electric main gear doors unlock and open, and the red "unsafe" light in the cockpit illuminates. Once those doors are fully open, power is removed from the door motors and provided to the gear drive motor. The gear will begin to retract, and the green gear lights will extinguish. Once the gear are fully retracted, an uplimit switch on a travelling nut assembly will remove power from the gear motor; an up-limit zone switch will then provide power to the gear door motor to close the electric main gear doors. Once the main gear electric doors are closed, the red "unsafe" light extinguishes and the cycle is complete.

Gear extension happens in the reverse order, but it should be noted here that the cycle is completed and power is removed from the system through a gear down limit switch in the nose wheel well.

Having discussed the normal operation of the gear, let's look at what can go wrong.

Unfortunately, as in all retractable landing gear systems, the biggest problem is that pilots too often forget to lower the gear. In the last five years, there have been

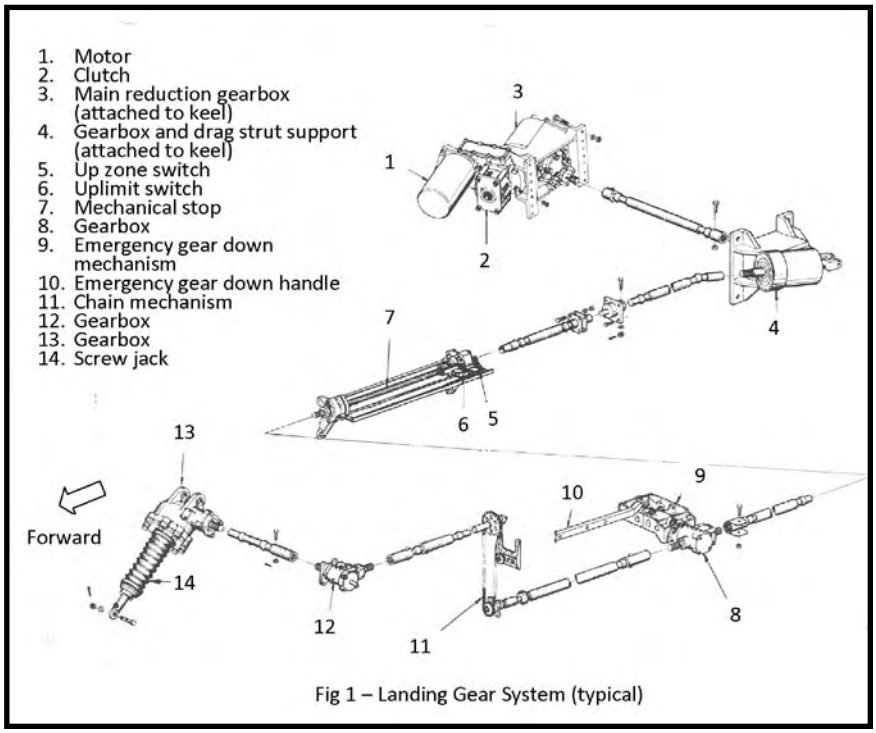

Fig 1 – Landing Gear System (typical)

three such incidents, and these were all expensive mistakes. The gear warning is tripped through a microswitch in the throttle quadrant when the power lever is retarded to approximately 0.2 inches forward of flight idle.

Some pilots prefer to set their flight idle fuel flows very low, below the minimum design fuel flow. This has the effect of causing the power levers to be further forward during the last stages of the approach. If the pilot is carrying power to touchdown with a little extra speed, or facing a strong headwind, and the gear have not been extended, the power levers may not be far enough back to close the microswitch and trigger the warning. For that reason, flight idle fuel flows should be set according to Mitsubishi's guidelines, and they are now required to be set within proper tolerances by AD 2006-17-05.

As an aid to pilots, MHI and MHIA endorse the installation of STC SA01300WI, a voice alert warning system which provides audio warnings through the headsets. This system clearly says "landing gear" when the gear warning is activated, and there can be no mistaking the warning intent or volume. The irony here is that all three "gear up" owners have installed the voice alert system in their airplanes – after the fact. The voice alert system is actually a reasonably priced system that warns of gear up issues, and also incorrect configuration for a number of takeoff and landing conditions as well as several other warnings.

Another issue that has been observed recently is incorrect rigging of the nose landing gear, primarily on short body aircraft, but potentially on long body aircraft as well. There have been three incidents of nose gear collapse, all caused by improper adjustment or installation of incorrect parts. The nose landing gear has two drag struts installed, one on each side of the trunnion (*Fig 2*). These drag struts support the gear in the down locked position, and must both be fully and evenly extended when the gear are down. To ensure even extension, a universal joint attached to the rear of each drag strut must be properly fitted. Unfortunately, in two of the collapse incidents, the wrong part number universal joint was installed. The third collapse was caused by installation of an incorrect drag strut link.

One symptom of an improperly adjusted drag strut is a "popping" sound from the drag strut. If you ever hear this popping sound from the nose wheel area during gear retraction or extension, you are obviously going to have to land, and a nose gear collapse is unlikely, but you shouldn't make any further flights until the gear are checked out by an MU-2 experienced mechanic. Repeated landings with these symptoms can eventually lead to collapse. This is the time to consult one of the experts at the MU-2 Service Centers. Because there have been several incidents where the wrong parts were installed in the nose landing gear, it might be prudent to have your maintenance facility go over the system thoroughly, paying particular attention to the rigging and operational checks. Service News 062 deals with nose gear rigging for short model aircraft and, when referenced in conjunction with the maintenance manual, will ensure proper rigging and adjustment.

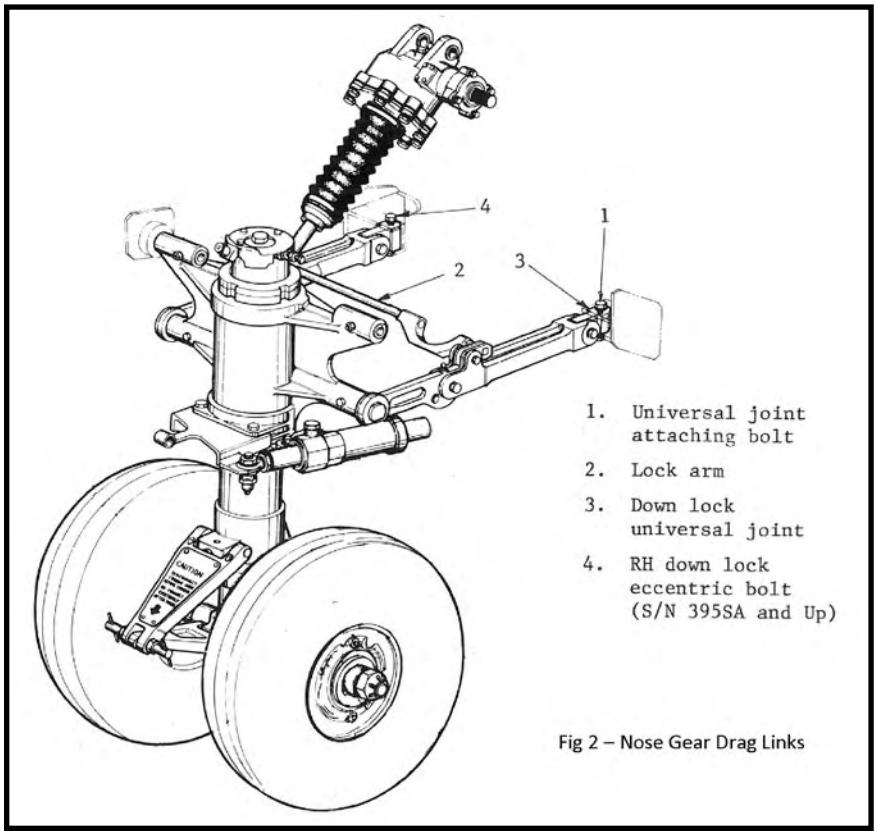

Fig 2 – Nose Gear Drag Links

Yet another potential source of stress on the nose gear system is improperly adjusted engines. Several years ago, one fleet operator complained that he was having chronic problems with nose gear damage.

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Investigation revealed that the engines for many of his aircraft were reversing unevenly, with the result that the airplanes would swerve or "wobble" as one engine came into reverse prior to the other after touchdown. Obviously, side loads were experienced and, over a period of time, cracks would develop in the trunnion and/or nose gear housing. The solution was simple. Proper adjustment of the engines to obtain even reversing resulted in this problem immediately disappearing. Incidentally, side loads on the nose gear can also result from improper crosswind technique. When lowering the nose wheel to the runway after touchdown in a crosswind, the pilot should carefully center the rudder to straighten the nose wheel while controlling his direction with increased spoiler inputs.

There have been few incidents of mechanical failure of the torque tubes and bicycle chain connecting the right main gear to the left main and nose gears. Initial and recurrent classes cover the various possibilities well, and MU-2 pilots should understand how one of these mechanical failures could affect the emergency gear extension process.

One incident happened about twelve years ago. After takeoff, the right main gear retracted but the left and nose gear remained extended. In this incident, the bolts that connected the gearboxes to the keel frames came loose (***see gearboxes, parts 3 and 4 in Fig 1***). This allowed the torque tubes between the left and right main gear to disconnect during taxi out. When the gear was subsequently raised after takeoff, the right gear retracted normally, but the left and nose gears remained extended because of the disconnection of the torque tubes between the right and left gearbox caused by the loose bolts. Since the linkage to the left gear and nose gear was disconnected, the travelling nut (from which most of the gear sequencing microswitches are activated) remained in the DOWN (full forward) position, and, of course, the nose landing gear downlock switch also remained in the down position. Sensing that the landing gear was already DOWN, power could not be applied to the gear motor to lower the right gear, and it remained in the UP position.

The subsequent emergency landing was handled well, the engines were feathered just prior to touchdown, and relatively minor damage resulted to the tip tank and right cowling. After this incident, Mitsubishi issued a Service Bulletin and revised the inspection manual to require regular torque checks on the bolts connecting the gearboxes to the airframe, and this problem has not recurred.

Like many systems in the MU-2, good maintenance involves using plenty of grease. Wear items include jackscrews and nuts, and are lubed every 100 hours or one year. Lube points and specifications can be found in the Servicing section of the Maintenance Manual. For extreme cold weather operations, MHI issued Service News 139 and 093/30-014 in 2001 providing additional tips for maintaining this system in the wintertime, including dealing with frozen and sticky electrical switches. With good maintenance, I have never personally had a gear malfunction. In fact, I have found the gear to be reliable and, in light of some of my landings, quite rugged. **AAOG**